# HANDRAILING



# SIMPLIFIED.

HODGSON.

# HANDRAILING SIMPLIFIED.

## SECTORIAN SYSTEM.

Being a novel method of finding the curves, twists, wreaths, ramps and cuts for handrailing over circular and elliptical stairs.

This method of finding the lines and angles for stair-railing does away to a great extent with the mystifying lines and references so necessary to build a handrail by any of the old systems.

BY AN EXPERIENCED ARCHITECT.

EDITED AND REVISED BY
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23 Warren Street.
1900.

# PREFACE.

Among the systems of hand-railing that have been introduced during the past sixty years in this country and abroad, not one of them is better adapted to the capacity of the average workman than the one presented in this volume. The system was first invented by Mr. Wm. Forbes, a well-known architect of Richmond, Va., many years ago, and was practised by him and others for a number of years, but did not make much headway, because of its lack of publicity. About 1874 Mr. Forbes made an effort to let the world know his system, and had a pamphlet published, in which the outlines of the system were fully explained, but, for lack of means and a knowledge of the methods of pushing such a book on the market, the venture was a failure, and very few of the books were sold. Shortly after Mr. Forbes died, but not before he had made several additions and improvements, which are embodied in the present work, along with other improvements, additions and corrections, that time and practise have suggested.

It is not claimed in this work that by this system a better rail can be produced than by other working systems, but it is claimed that by this system handrails of any size or shape can be produced in less time and with as little material as by any other method, and that a fair knowledge of handrail-making can be obtained by this system with less labor than by any other system known.

The SECTORIAN SYSTEM, as this system was first called, requires neither gauge or elliptic curves, no piece of stuff wider in one part than another, and no piece thicker than the width of the rail; these are qualities possessing a commercial value in these days of costly materials and expensive skilled labor.

This system, while not perhaps as scientific as some, is not long-winded; it is a simple short cut to satisfactory results, which are accomplished without wading through the toilsome abstruse system of Riddell, Nicholson, De Graff and others.

A brief study and very little practise will enable the workman to understand the whole system. THE EDITOR.

New York, January, 1900.

# CONTENTS.

# HANDRAILING SIMPLIFIED.

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## SIMPLE, EASILY UNDERSTOOD AND EFFECTIVE—BY AN EXPERIENCED ARCHITECT.

The first things to be considered in a study of this system, are the tools or instruments required to accomplish the results desired.

The following description and diagrams will initiate the reader. Follow each line and instruction clearly, or, better still, make drawings same as shown, only on a larger scale. and you will get an insight into the system that you could not acquire otherwise.

Fig. 1 is the sector, on which the system is founded; it is made of two boards joined together with hinges, so that the joint on the face will be close in any position; the edges beveled so as to allow it to fold back to an angle of

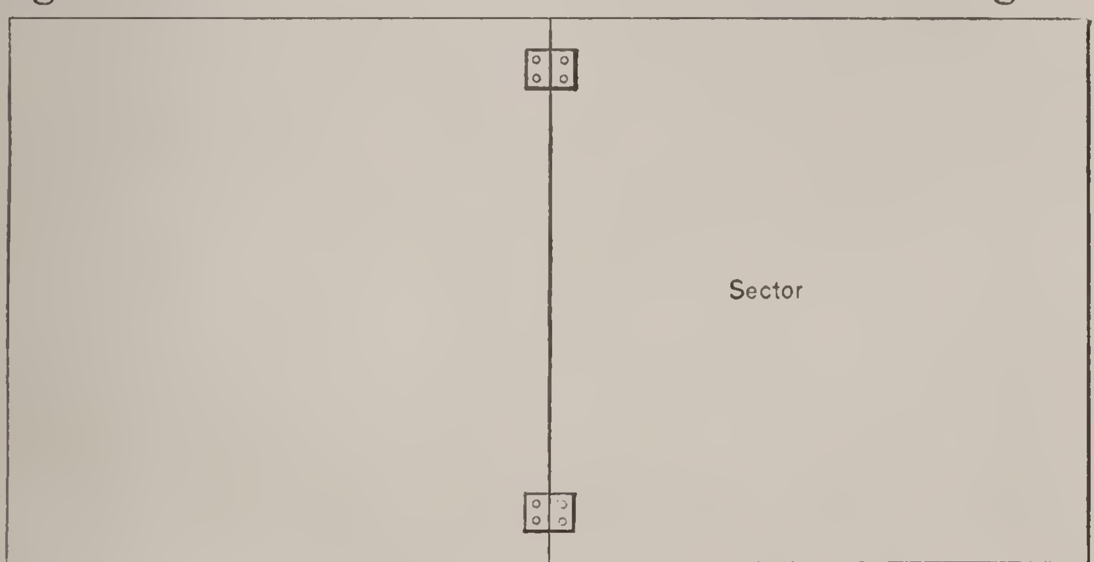



Fig. 1

ninety degrees. Each leaf may be two feet long by one foot wide, with the ends clamped to prevent warping.

Fig. 2 is a section of Fig. 1, showing a brace of wire to keep it in position to any angle.

Fig. 3 is the tangent bevel, used on the face of the sector to obtain tangents.

Fig. 4 is the bevel used on the sector and tangent bevel, and produces the spring and plumb bevels on wreath pieces of rail.

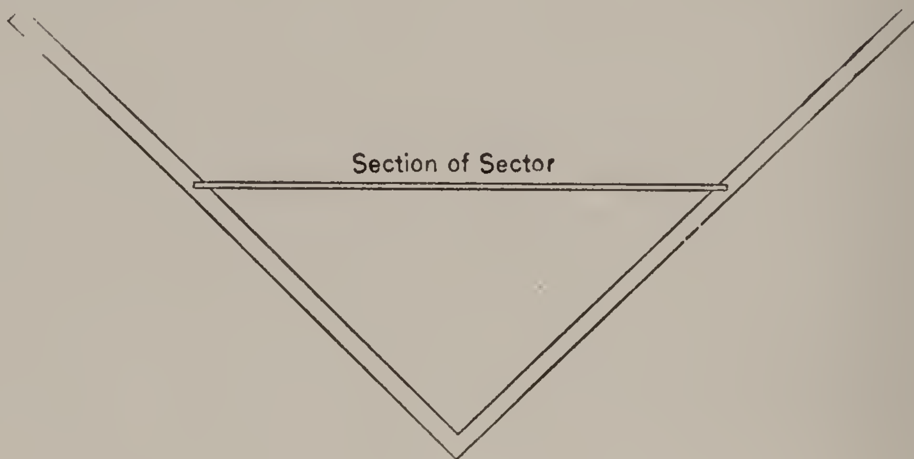



Fig. 2

Fig. 5 is the plan of a semicircular piece of wreath. The horizontal lines of the triangles show the stretch-out of the convex and concave edges of the wreath, which is obtained by dividing the radius of the circle into four parts, taking three of them in the dividers and extending to five as shown; then draw lines, cutting chord as shown. The lines of the two triangles are parallel to each other.

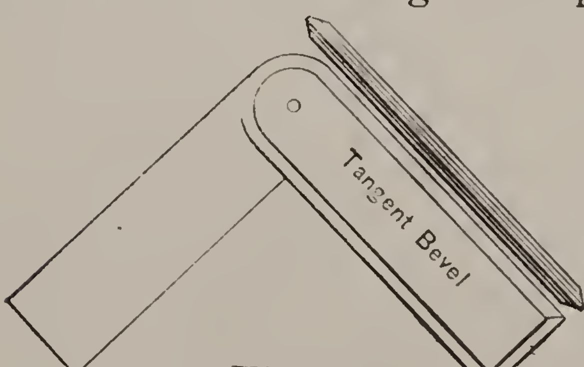



Fig. 3

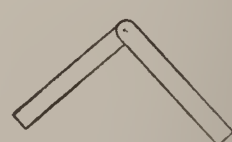


Fig. 4

Fig. 6 shows the method of obtaining the curve and joints of wreaths after the tangents are drawn from the sector.

By close inspection it will be seen that two lengths are shown—the dots showing the centre line of the curve to each piece. This will be shown to better advantage in succeeding drawings.

Fig. 7 shows the scale of the diagrams and is intended for all the illustrations that follow.

Having a thorough knowledge now of the tools or instruments to be used, we will proceed to put this knowledge to use by laying out a rail for a platform stairs on a level landing having a six-inch cylinder or well-hole and a three and a half-inch rail. Before proceeding further,

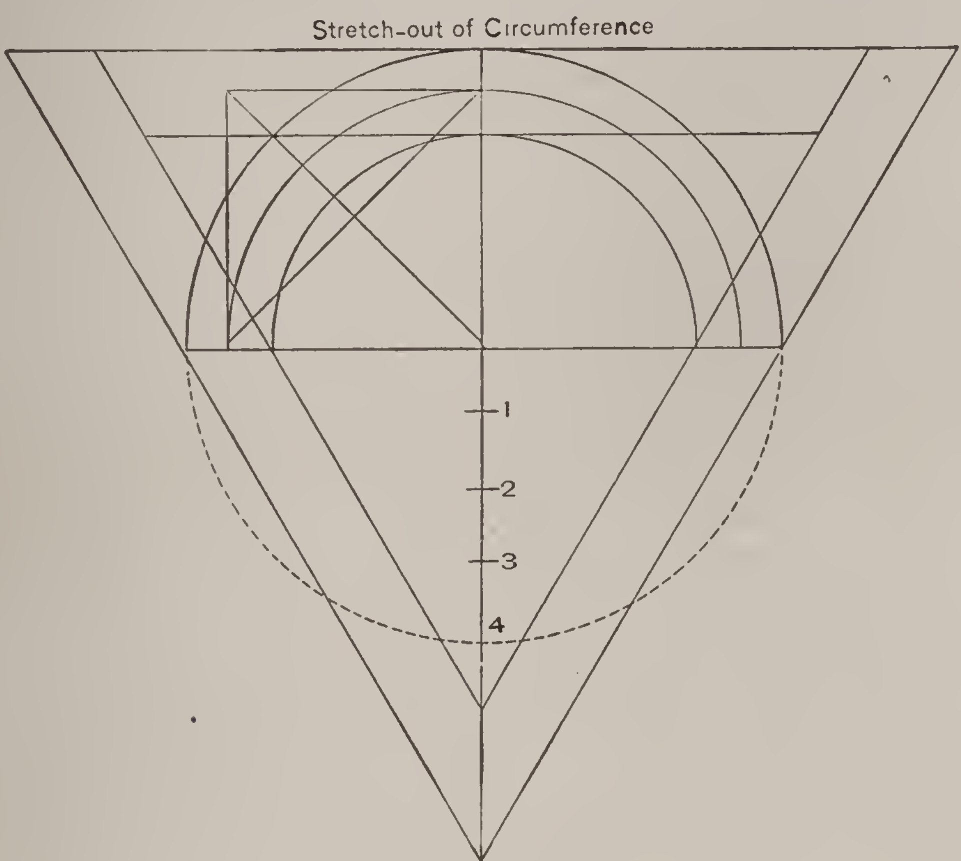



Fig. 5

however, it will be just as well to explain that this book and all that is shown therein has nothing to do with building the body or carriage of the stairs; it simply refers to building the rail only, with the understanding, of course, that the stairs are built in accordance with some recognized system; for be it known, that a circular, or dog-legged stairs, built and finished by an inexperienced hand, can never be surmounted by a rail that will have a graceful appearance and properly elevated, unless some recognized principles are adhered to.

For simple and easy methods of constructing stairs in a proper manner, the reader is referred to "Stairbuilding Made Easy," which contains pretty nearly all the information concerning the erection of the bodies and carriages of stairs the students will ever be called upon to exercise. But, to our subject:

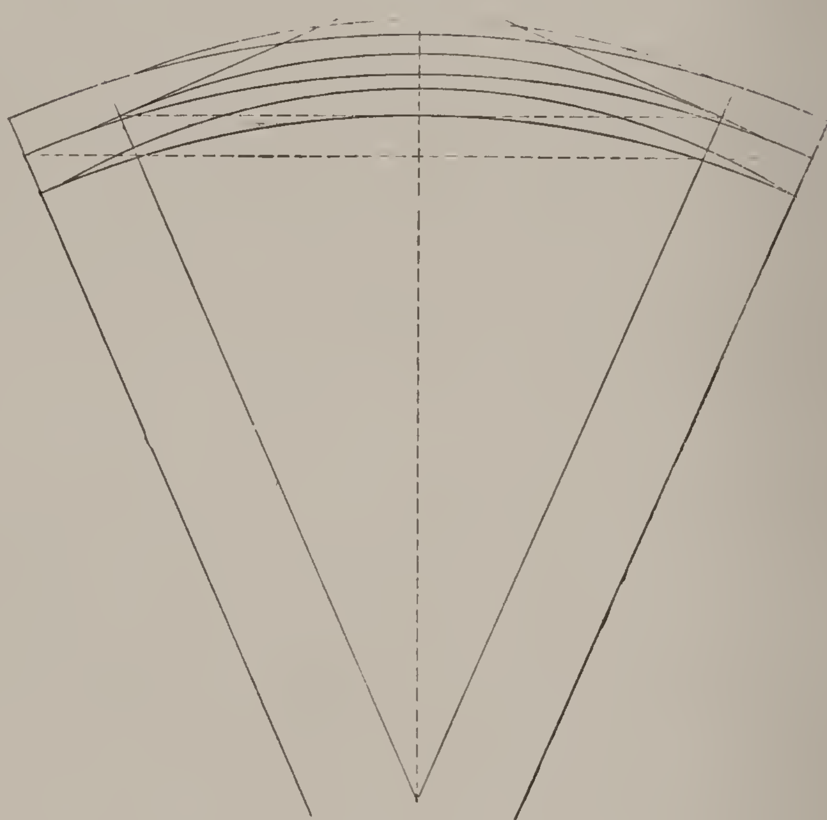


Fig. 6

Let Fig. 8 show the stretch-out of rail as at *a* inside and out. Through the centre of the rail, at the top and sides, are tangents which intersect, and which are of the first importance in the development of this work, as all rails are worked from centres.


Fig. 7

Fig. 9 is the tangent bevel, so called, as the instrument used for obtaining the oblique bevel across the face of the sector, Fig. 11, when closed to a right angle or any other angle required.

Fig. 12 is the lower part of wreath; the form of which is obtained by first spreading the sector and getting the distance from *b* to *c*, Fig. 10, and applying it to the sector each way as shown; then raise perpendiculars from these points and draw a base line, starting at *b* across to the left, and set up half raiser at *a;* then from *b*

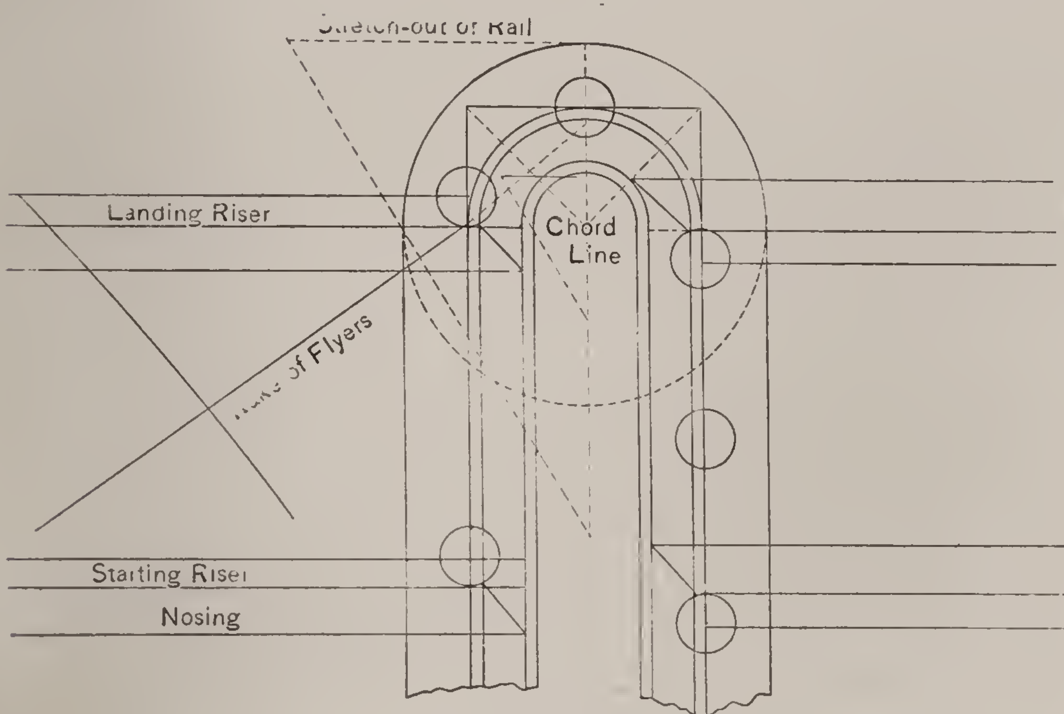



Fig. 8

through *a* draw the line *b a*, which will be the rake of the wreath. The lines from *b* down and from *c* up, show the rake of the flyers. Now, having obtained this line, close the sector to a right angle, place pins on the line, and place the tangent bevel astride the hinge joint, with the inner edge of each blade thinned so as to lie close to the pins, and see the edge fits the line exactly, as much depends on accu-

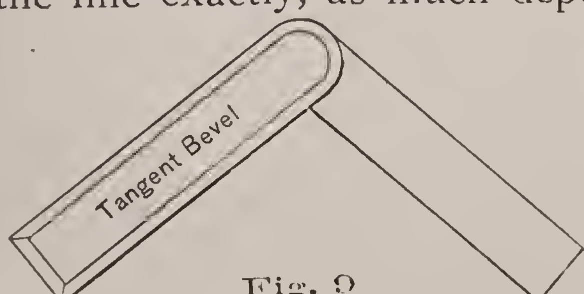



Fig. 9

racy at this point. Having obtained the bevel, and while in position on the sector, take the spring or small bevel and apply one blade to the face of the sector and the other to the tangent bevel at a right angle with the blade; this gives the spring and plumb lines for the concave and convex edges of the rail, and by removing the slabs as marked, the inner and outer twists are obtained for the application of the falling moulds, which gives the twist of the top and bottom faces, and also the thickness of the rail.

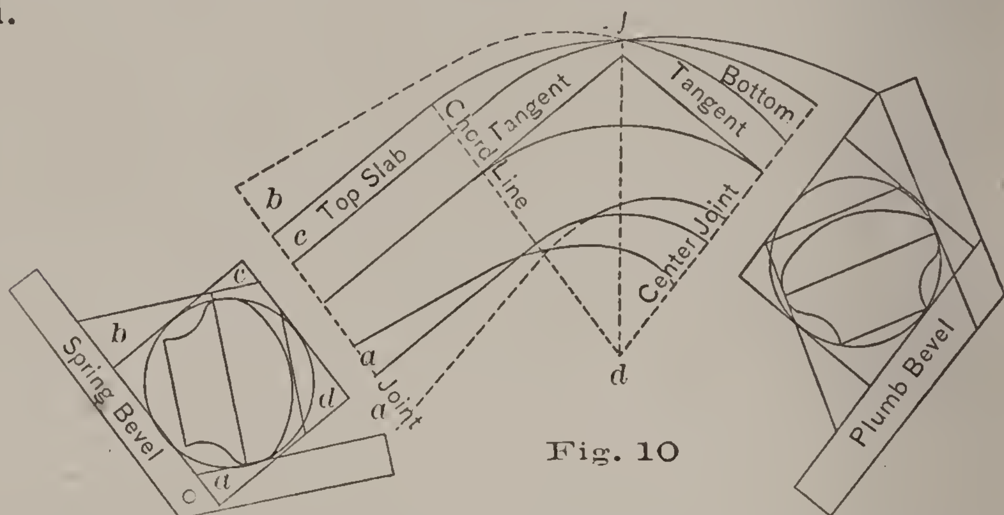
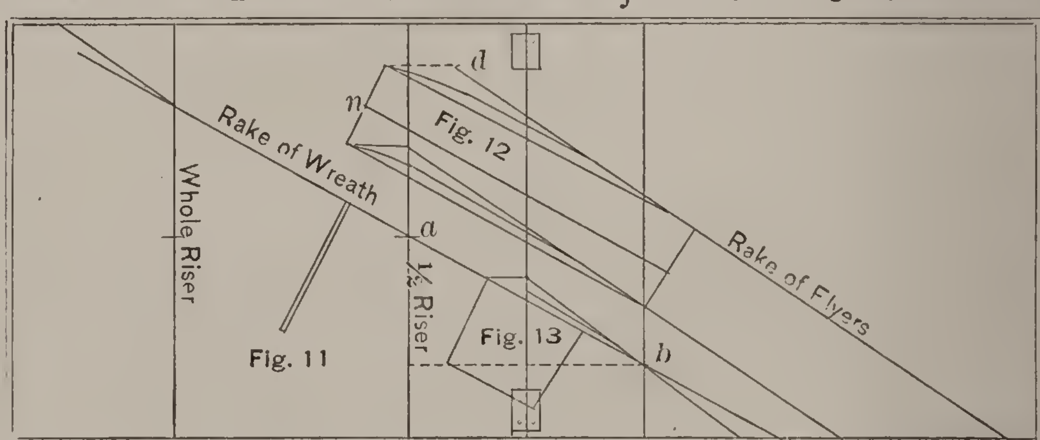



Fig. 10

Now remove the tangent bevel from the sector, and lay it flat on the board of which the mould is to be made, and mark from the inner edge of it each way to the chord line on one side and to the centre joint on the other. The




distance is obtained by measuring on the raking line of sector from *a* and *b* to the centre. Then, from these points, on Fig. 10, draw at right angle with the tangents the chord line and centre joint until they intersect at *a*, which makes the point to describe the circle for the wreaths both concave and convex. The sections at the end of the wreath are so well defined, as also the application of the bevel, that further explanation is deemed unnecessary.

Figs. 12 and 13 are the moulds for the concave and convex surfaces of wreaths, and must be the width of the thickness of the same, and obtained as shown on the sector. Draw a line parallel with rake of wreath; then set off the thickness, and extend the line to the perpendicular on the right; then draw rake of flyers extended to *d*; then take the distance of the stretch-out at Fig. 8 and extend across the sector at a right angle, and from the perpendicular line on the right to point *n* on the left; the curves between the rake of wreath flyers give the ramp of rail which completes it.

It is best to make the falling moulds of tin, and bend them to the twist as evenly as possible, and secure the ends. See that the concave mould is pressed firmly in its place, and well secured to the wreath. The centre perpendicular line should be drawn on the face of both moulds, giving the rake of the plank from the face. In applying the moulds see that the centre line corresponds with the centre of rail, and if the moulds are required to be raised or lowered, do not raise one end more than the other. When all is made secure, take a good hand or panel saw and kerf in top and bottom till the saw touches the edge of the mould; then work off to the bottom of kerf, and the thickness and twist of wreath are obtained. All joints are made by squaring from tangents and from the face of the plank, which should be out of wind or twist when the mould is taken. It is seen why I advise tin for the falling moulds—good stiff pasteboard would answer with a very careful person. The tin could not injure the saw much, but the saw might injure the rail by disregarding the pasteboard edge.

If this explanation is not sufficiently explicit, what is lacking must be gathered from other portions of the work.

The application of the face-mould on the wreath-piece, as indicated by lines and letters *a, a, b, b, c, c* and *d, d,* will show the slabs to be taken off. By reversing the face-mould it will answer for both pieces of wreath.

To those who have no acquaintance with the art of handrailing, some portions of the foregoing may seem rather misty, and to these, if they desire to study this interesting art, I would advise to obtain a copy of "Moncton's Geometry," where they will find some explanations of geometrical terms that will materially aid them in understanding this system of handrailing. In an experience of many years, I find it the most difficult to get the young student to understand the working of the sector, if he has to learn it from a book only. Thirty minutes' study over the board itself would give so clear an insight in the system that scarcely any further instructions would be necessary.

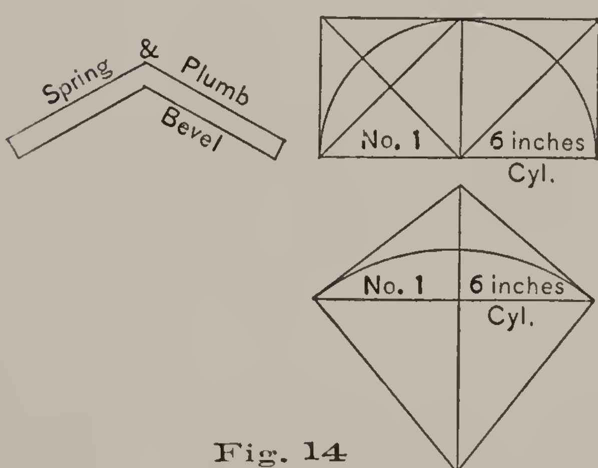


Fig. 14

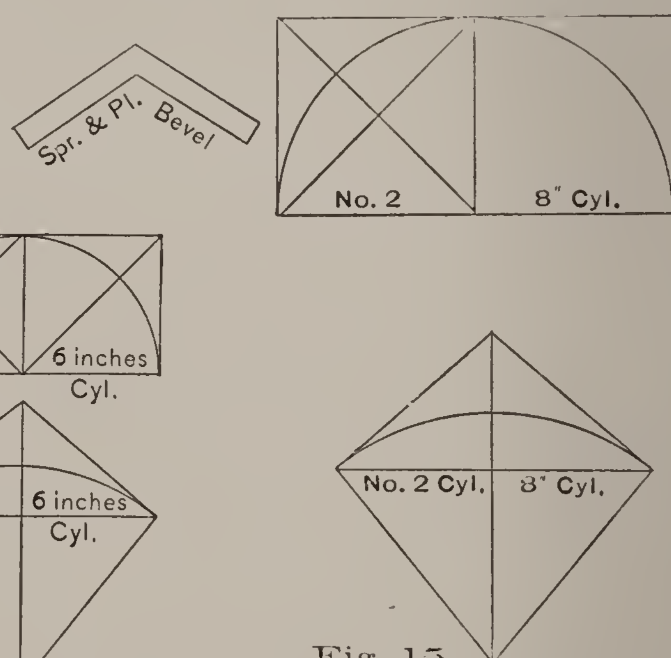


Fig. 15

If the student will experiment a little with the sector, laying out the pitch of the stairs on one wing below the platform, and the pitch above the platform on the other, connecting the lines at the hinge joint, the principle involved in this method will appear to him at once, and all the rest will be comparatively easy. Try this; it will well repay you.

In order to simplify matters, I herewith present four examples of plans, varying in size from six to twelve-inch cylinders, or the same from centre to centre of rail on each side of cylinder with their wreaths, drawn from tangents taken from the sector, with spring and plumb bevels to each.

In every case these bevels are the same, when the pitch-board is the same for different flights. Fig. 18 is a plan of a winding stairs, with cylinder twenty-four inches.

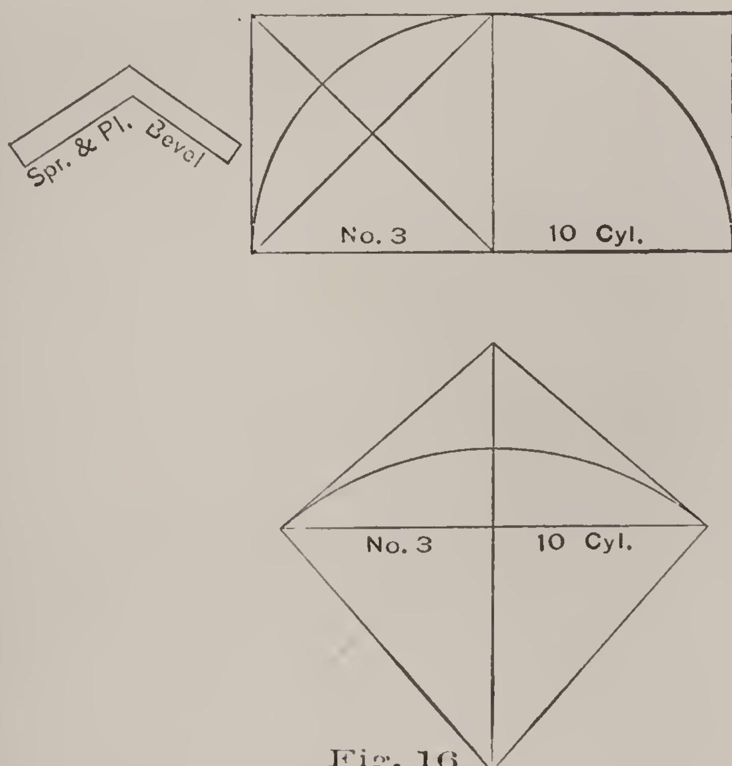



Fig. 16

This plan is in very common use, hence the need of giving an example on this system, showing the simplicity to which the whole subject is brought. For instance, required: the wreath for a circular stairs, the cylinder being

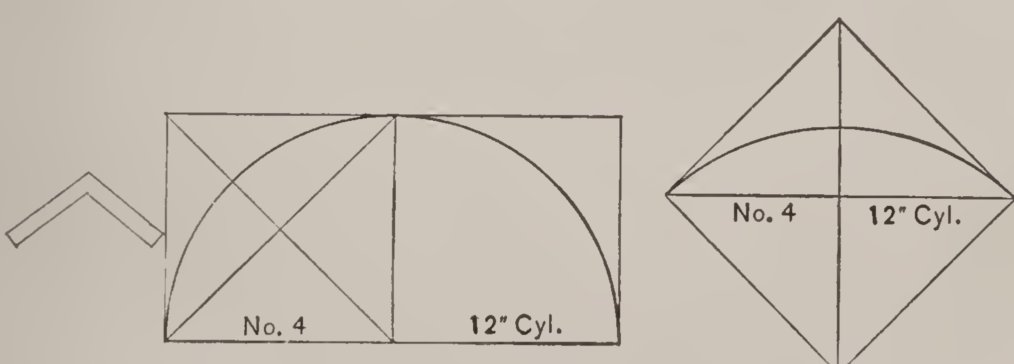



Fig. 17

two feet, and eight winders in the semicircle. Suppose the space to be eight feet wide, having three feet length of tread on each side of cylinder. First, draw the chord

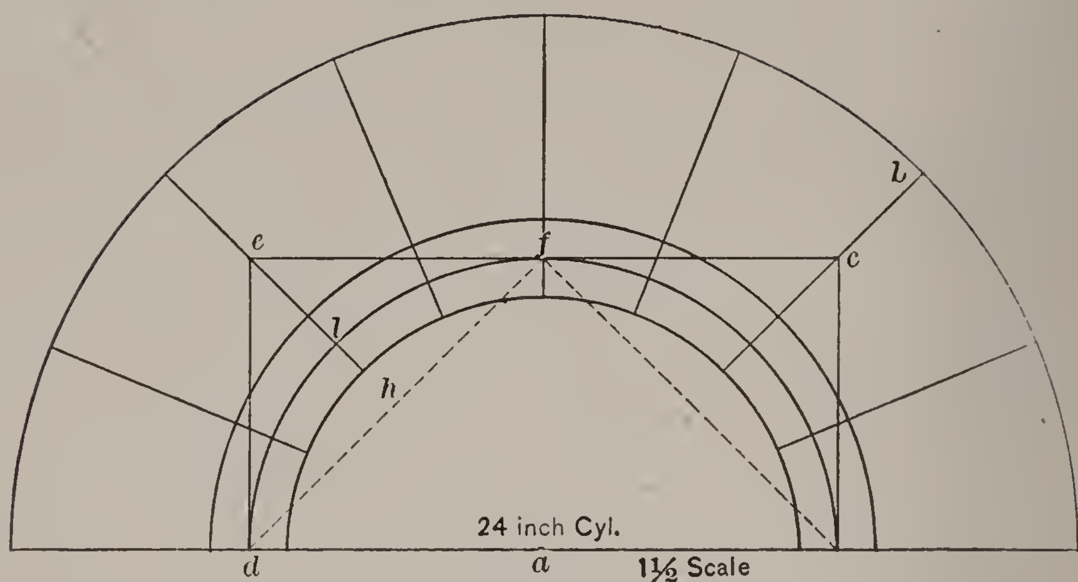
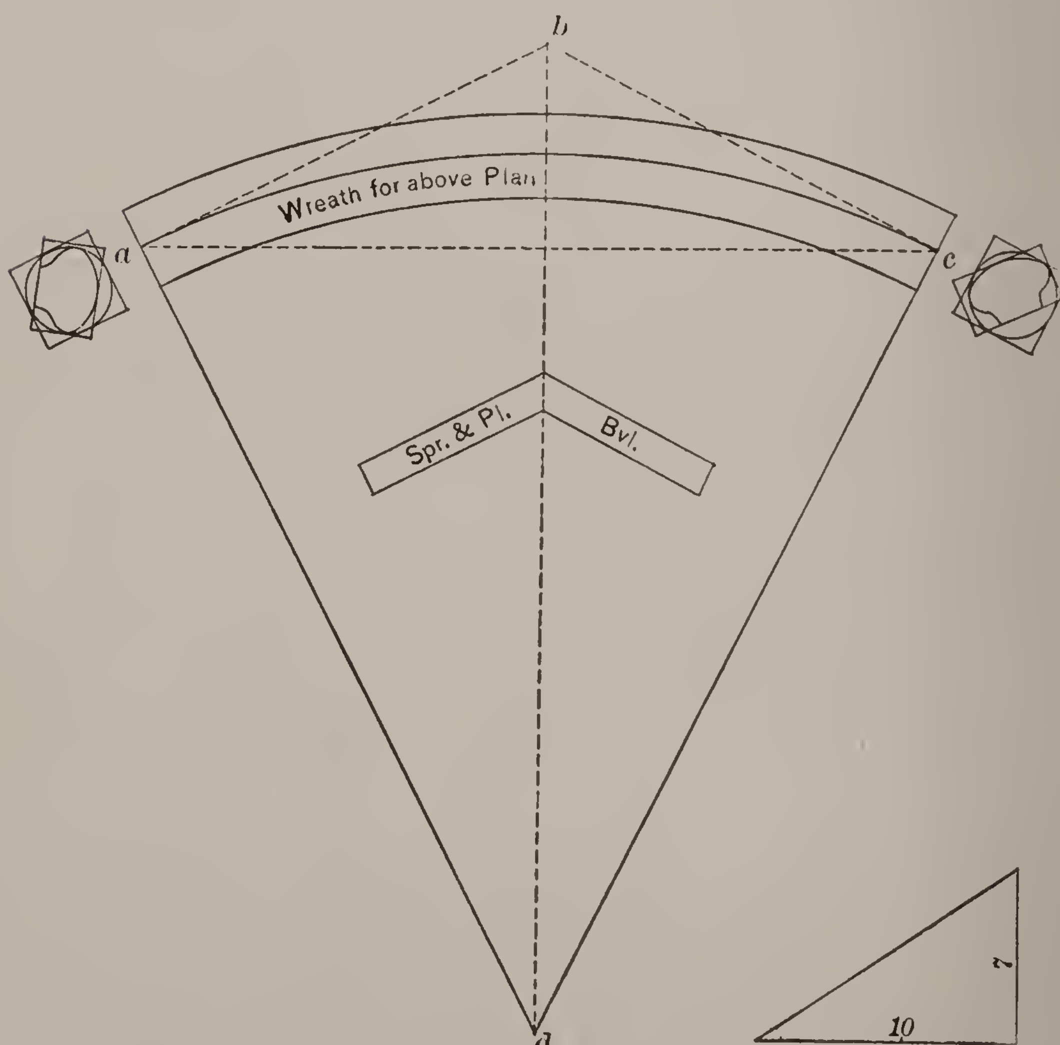



Fig. 18




Pitch Board

Fig. 19

line and get the centres; draw the semicircle of rail, which will be 24½ inches to centres; next draw tangents, as in Fig. 18, cutting centre of rail at right angles on each side; then, from the centre of chord line *a*, draw lines cutting through angle of tangents *e* and *c*; again draw through back of cylinder at a right angle with chord line. These lines give the face of the risers of four winders in the cylinder. Now divide the spaces, and draw as before, and you have all the winders. Now unfold the sector to a level plane, or, in other words, lay it flat on your bench or on the floor, cover the face with white paper pinned on at the four corners; draw a base line across the face; then on this line set off from the joint, each way, the distance from *d* to *c* (Fig. 18), and from *e* to *f*—*e* being the joint, the sector forming the right angle *d, e, f*; raise lines from those points, *d* and *f*. Now get the height of four raisers, which in this case is twenty-eight inches, and is also half of the wreath; now draw the angle across the face of the sector from *d* to *e*, Fig. 18. Now fold the sector to a right angle, and secure it in that position by the wire brace across the top end; now turn the sector and let it rest on its two edges, with the angle upwards; now apply the tangent bevel across the angle, with each blade ranging with the angle line of the rake of winders, which give the tangent as at *a, b, c*, Fig. 19.

The length from *a* to *b*, Fig. 19, is the height from *d* to *e*, Fig 18, on the rake line. While the tangent bevel is in position across the sector, take the spring and plumb bevel and apply one blade on the face of the sector, and the other against and at right angles with the tangent bevel; this gives the spring and plumb bevel, which in this case is the same, and gives the twist of the wreath from *a* to *c*, Fig. 19.

After the length of the tangents, *a, b, c*, are procured, as shown by dotted lines, draw down at right angles with tangent lines on each side, also plumb lines from *b* to *d*, intersecting at *d*, from which point describe the wreath from *a* to *c*. If the piece is too long for the dividers, stick a pin at *a* and *c*; then take a bevel with each leg as long as wreath piece, with inner edges straight; then from the chord line, *a, c,* at the centre, set up the distance from *h* to *i*, Fig. 18. At this point place the angle of the bevel, each leg touching the pins inside and with pencil in the angle, and, pressing the legs against the pins, describe the piece from *a* to *c*.

The spring and plumb bevels give the convex and concave twist, to which apply the falling moulds on both sides, which in this case is the width of the thickness of the rail, and perfectly straight. The spring and plumb bevel having given the horizontal line on each section of the wreath, the centre of the moulds must be placed at these centres and drawn close to the surface and pinned. Tin is the best for these moulds, as the best preventive from kerfing too deep, as might be the case if pasteboard be used. After kerfing, remove moulds, and work off to lines, and you have top and bottom face of rail. The same face and falling mould will answer for both pieces of wreath, as they are both the same shape.

All of the plans shown in these four examples may be treated alike, and on the same lines as the example wrought out.

The term "kerfing," as applied here, simply means running a saw in the wood to be used for rail until it strikes the lines of the falling moulds, and is intended to lessen the labor of removing the slabs from the wreath.

In each case it will be seen that the sector is used only on one-quarter of the circle, which turns the rail in a line at right angles with the straight part of it, or square with it. The other half of the semicircle is formed exactly as the first half, with the exception, of course, that the straight part of the rail is attached to the upper part of the wreath instead of the lower. Half of a wreath, with sections of rail, is shown at Fig. 19. These sections show the positions of rail at each end of stuff. Mark shape of rail as shown, then the matter of working down is not a difficult one. The plumb and spring bevel are shown on centre line. The pitch-board is also shown at Fig. 19; the tread is marked ten inches and the rise seven inches.

At Fig. 14 the plan is for a six-inch cylinder, or twelve inches across the circle. The second cut, No. 1, in Fig. 14, shows the cylinder six inches, which is half of the wreath required for the completion of the stairs having a cylinder stretch with a six-inch radius.

Fig. 15 shows a plan stretch with an eight-inch radius. The lower figure, No. 2, shows the half of this plan with base line and curve.

Fig. 16 shows a plan described, with a radius of ten inches. No. 3 shows the half of the plan, with centre line of wreath. Fig. 17 is similar to the other examples, only that it is described with a radius of twelve inches, thus making a distance of two feet on the base line between centres of rail. Fig. 4 shows one-half of the plan with centre line of wreath.

It will be noticed that in this description every part of the circular opening around which the rail and steps revolve is called a cylinder. This is not exactly correct, but as the term is one in use among stairbuilders, I make use of it to convey the ideas I wish to formulate. At the end of this work I will endeavor to explain, as well as I can, everything I may think necessary to give the student a thorough knowledge of this system of handrailing. I have tried to be as plain in my language as possible, and to strip the matter of every form of pedantry and technicality, and will continue in this line to the end.

Figs. 20 and 21 show two views of a platform stairs, Fig. 20 a plan and Fig. 21 a sectional elevation.

The plan shows the landing and starting riser on the line with the chord of the cylinder, placing the whole of the cylinder in the platform, thus avoiding the additional labor of curving the nosings, as would be the case if the treads were made winders and occupied a part of the space now taken up by the semicircular platform. By this method a handsome and tasteful arrangement of balusters and wreath is effected, and the cylinder is encircled gracefully by the rail and turned work, and the landing is spacious and easily executed.

It will be seen that these figures show a cylinder two feet in diameter, and the objection often urged by stair-builders is that the wreath rises too high for the half riser at the centre of the cylinder, and therefore the steps in the platform cannot be avoided. I claim that, according to the Sectorian System, the difficulty is entirely removed, and the wreath-pieces as easily worked out as any other part of the rail, when properly understood. The wreath-

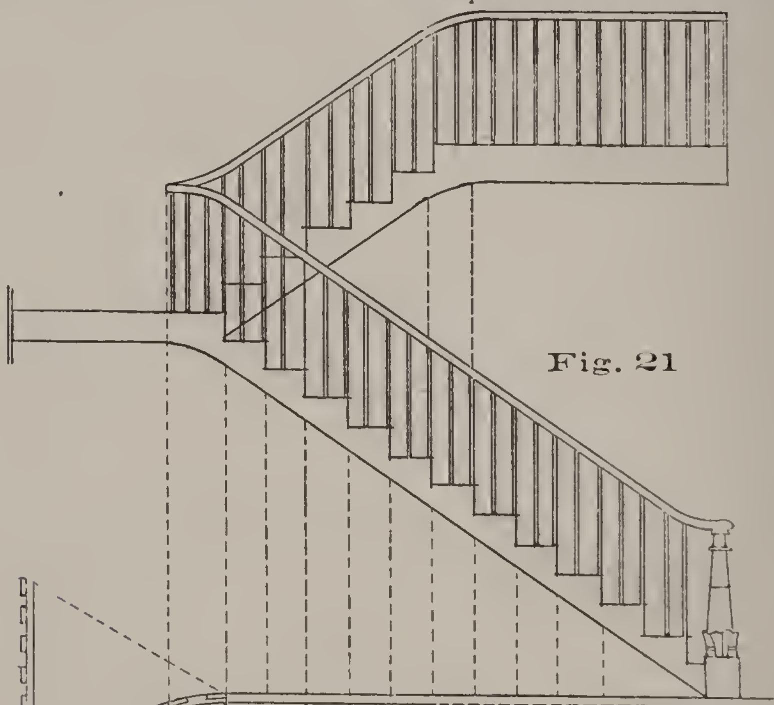


Fig. 21

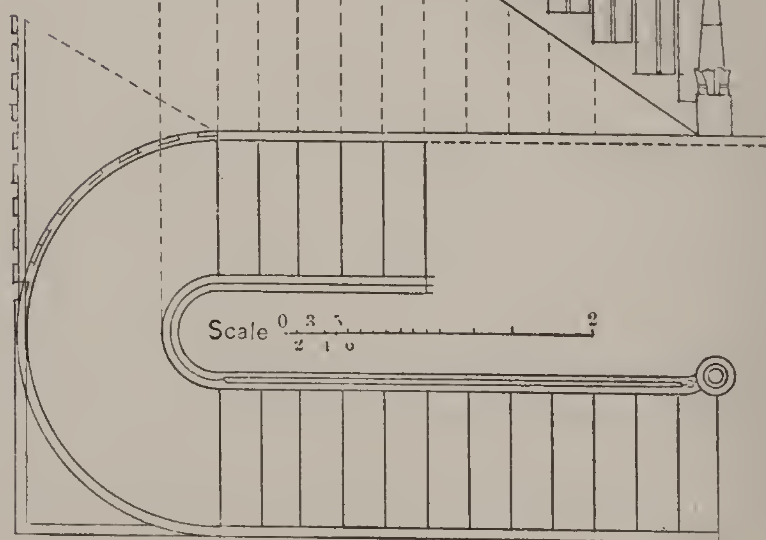


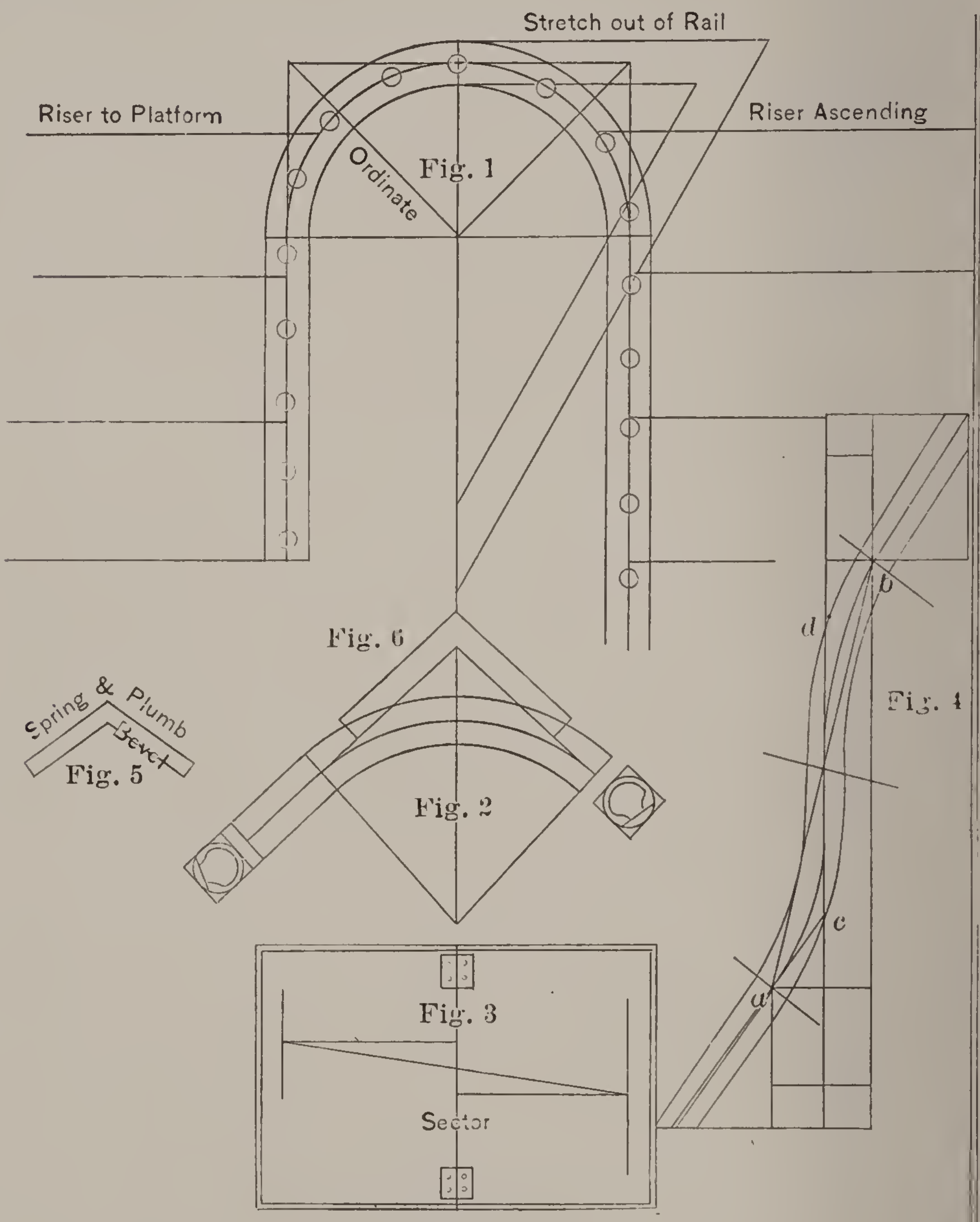
Fig. 20

pieces are not required to be any wider in one part than another, and no thicker than the width of the rail in any part. The falling moulds for wreaths in late years have fallen into disuse and are eschewed by most authors on the subject of handrailing, and I have been uncharitable enough to think it a want of knowledge as to the right use of those moulds, which to this system are indispensable. The wall-string shows my method of bending and keying the same. On other pages it is shown how this wreath is worked. These drawings are about a quarter of an inch to the foot; having been reduced somewhat from the original drawings; this, however, is immaterial, as each flight of stairs will require to have drawings prepared especially. Such drawings when made for actual service should be made full size on a floor or on a drawing board, as working from full-size drawings is very much easier than when the drawings are made on a smaller scale; besides the student will be more likely to discover omissions in the drawings, and he will get a better grasp of the work in hand by employing the larger scale for his drawing.

On Fig. 20 it will be noticed that a plan of the stretch-out of the wall-string is shown, notched and ready to be bent and wedged to shape. These strings are always better when bent and wedged over a rough made cylinder; but I will talk these things over at the end of the book, as I purpose continuing the subject of handrailing and stair-building to a considerable extent.

We now come to another form of stair, Fig. 1, which is exhibited in Section First. This example shows the ground plan of a platform stairs, with one-half the landing and ascending treads placed in the platform. The cylinder is of larger size than is generally used for this kind of stairs, and I give this example to show that as easy and as graceful a wreath can be thrown around this as any of a smaller size.

Fig. 2, in this Section, shows the lower piece of wreath with a part of straight rail attached. The sections of rail at each end show the direction given by the spring and plumb bevels, which are the same. The bevel, Fig. 6, astride the tangents of this figure, shows the angle as obtained by the sector, Fig. 3, which, when folded to an angle of ninety degrees and each blade placed on the line, shows the pitch of half a riser from the chord line to the centre of the cylinder. The angle is obtained, as shown, for getting the tangents of one-half the wreath, one mould answering for both pieces by reversing the end. The shank may extend as far as the thickness of the stuff will allow.




Section One

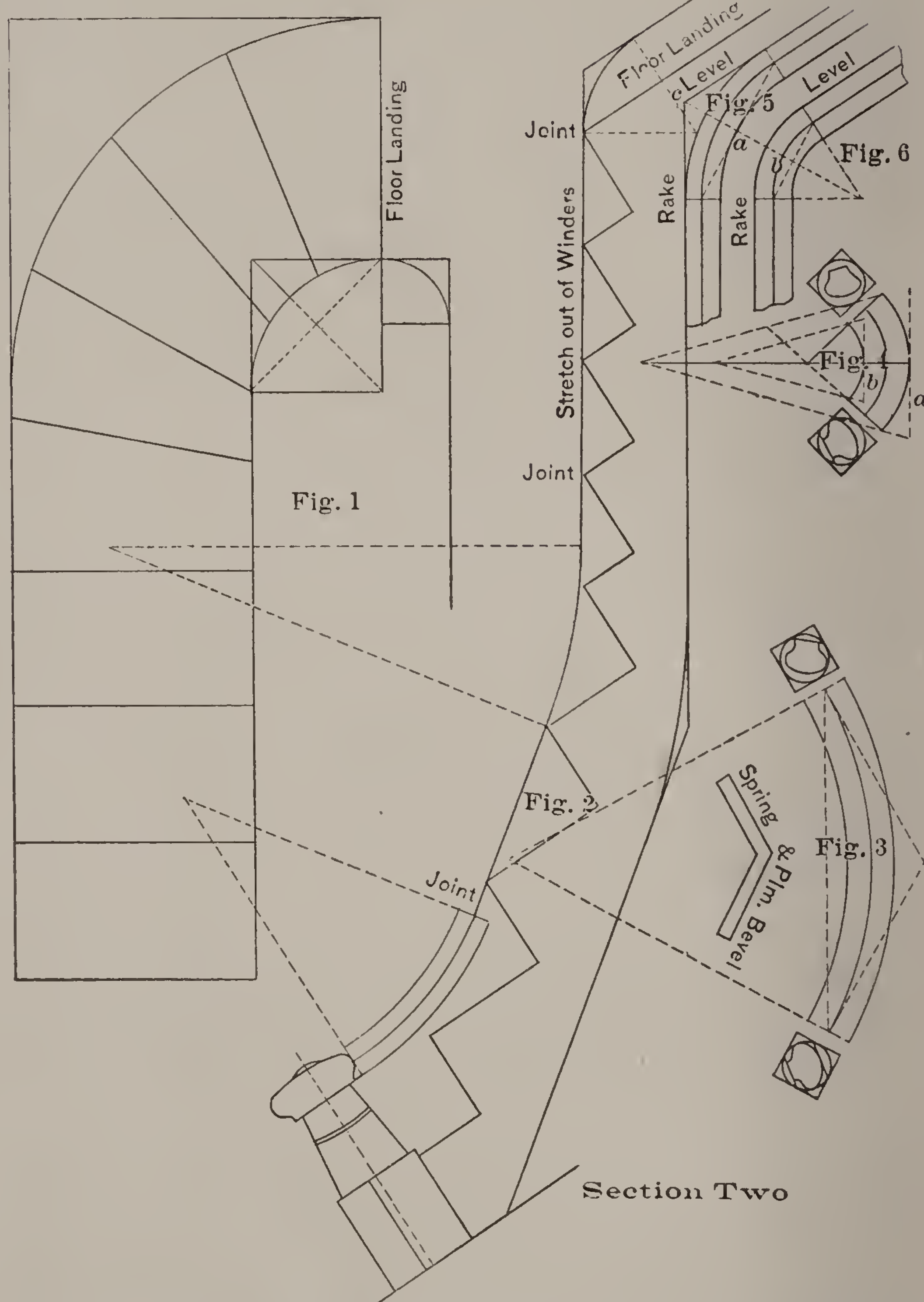
Fig. 3 shows the sector with the line showing the rise and the horizontal lines, giving the height of half a riser.

Fig 4 shows the shape of the outside falling mould, and is obtained by getting the stretch-out of convex sill of wreath from face of the two platform risers around that portion of circle on the platform; draw a line the length of stretch-out, which in this example is two and a half feet; at the ends of this line set up and down a half riser, and draw a chord, cutting right line in the centre; then set up and down a flyer, and connect at *a* and *b*; extend the rake of the flyers and connect at *c, d,* on the right line—this gives angles for making easements by intersecting lines; after which set off for top and bottom lines the thickness of rail. The inside falling mould is obtained in the same manner. When the slabs are taken from the convex and concave sides of the wreath which gives the twist, then apply these moulds, centre to centre with wreath. If the stuff is scant, they may be raised or lowered parallel with centres; and when made secure, kerf in with a hand saw to the edges of the moulds and remove the surplus wood, and you have the top and bottom twist without the use of gauges or guesswork, and as the plate shows, without the piece being wider in one place than another and no thicker than the width of the rail, and always sawed square from the face of the plank.

On Section Second is shown a stairs with winders, starting below the chord line and landing at the quarter circle. In some situations the space may not be of sufficient width to allow a large cylinder in the turning, and contraction has to take place somewhere. The steps are as narrow as convenience will allow, and the landing above, the same. The winders must have sufficient width to receive, without crowding the balusters; hence the necessity of making one part of the cylinder larger than the other, and the upper landing as laid down on this figure.

As before stated, all the lines are the centres, and as Fig. 1 has only one line, and a part of the elevation Fig. 2 the same, of course the width and thickness must be set off each way from this line. The steps are shown half their length, and the tread ten inches wide.

The plan is so plain that a further description is deemed unnecessary. The newel at No. 2 shows the height from the floor by adding the length of a short baluster to the shaft.




Section Two

The elevation shows the stretch-out of the winders in the wreath, the ramp at the newel, and also at the beginning of the winders.

Fig. 3 is the lower wreath piece, with bevels and twist marked, and needs no further explanation.

Fig. 4 is the upper wreath-piece, and is procured in the same way.

Figs. 5 and 6 are the convex and concave falling moulds.

The chord lines *a* and *b*, Figs. 5 and 6, are the stretch-out of the wreath, Fig. 4, at *a* and *b*, and shows the length of the convex and concave falling moulds. They are drawn to rise half a riser above the floor, so as to admit a long baluster on the landing above. To obtain the falling mould, draw lines on the rake and upper level, intersecting at *c*, Fig. 5; then take the stretch-out *a*, Fig. 4, and apply it at Fig. 5; then square down from rake and level, to intersect at *d*, then from this point draw the curve and width, and you have the convex, and by the process shown at Fig. 6 you have the concave moulds for the upper ramp.

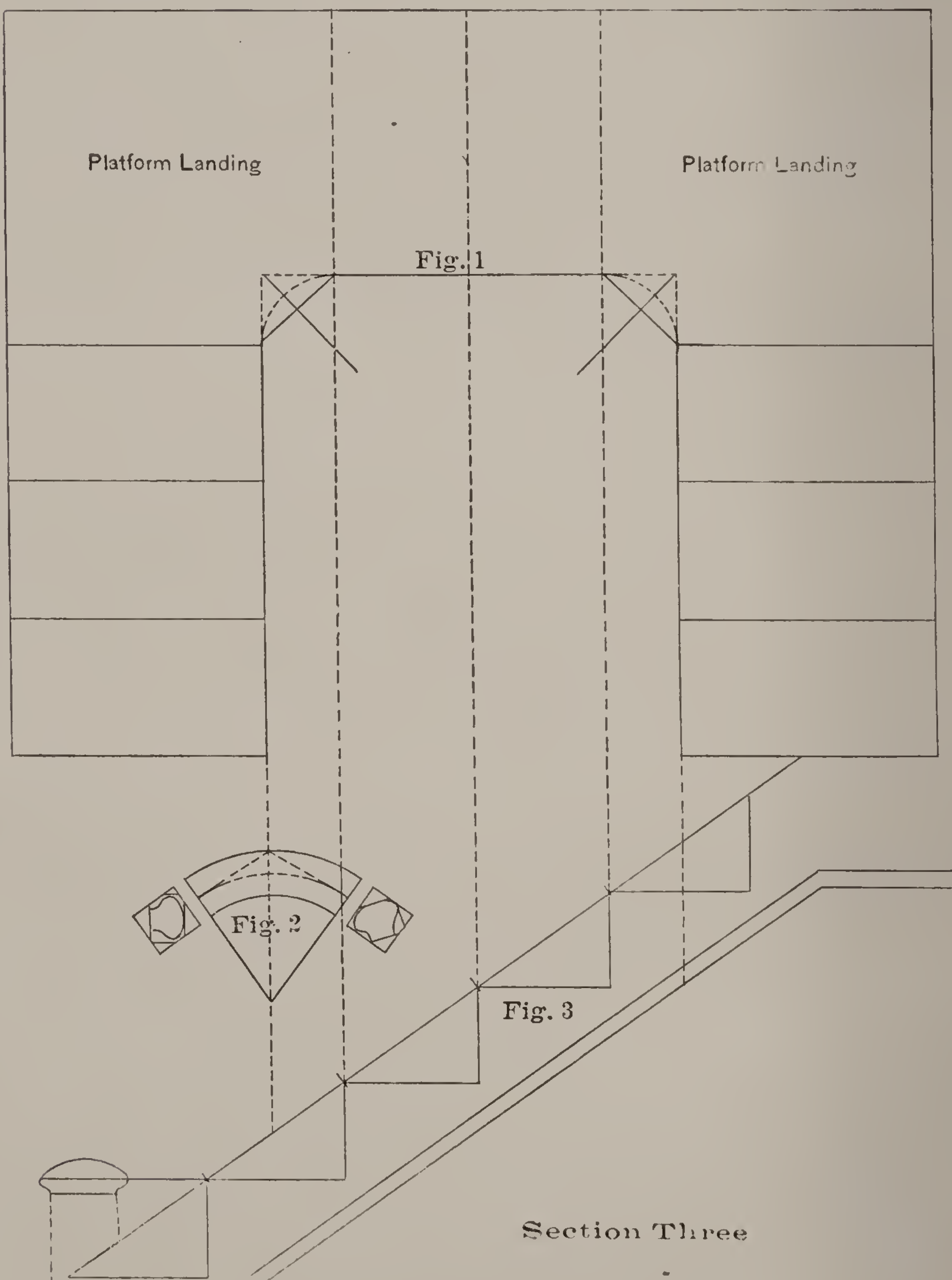
I have endeavored to make these examples as clear as possible, and I think, with the sector before him and the plan of the stairs the workman will be able to understand what I have intended to convey, and when once he sees through the sectorial workings, he will experience no further difficulty in making any kind of a rail.

Here is shown at Section 3 a stair that is sometimes necessary to meet odd conditions. It is a plan of stairs with two platforms, landings, and two quadrant wreaths with two flyers intervening. Where it is desirable to avoid a large cylinder, and the width is too great for the length of the steps, this plate shows one of the best methods for overcoming the difficulty. It will be observed that by the use of the quadrant wreaths, the size laid down, which is just the rise of one step each, the rail is made straight from bottom to top, each wreath being the rise of one step only, as shown at Fig. 1.

At Fig. 2 the wreath-piece is shown with the spring and plumb bevels, which gives the twist of the rail, and which by being reversed gives the lines for both pieces of the wreath.

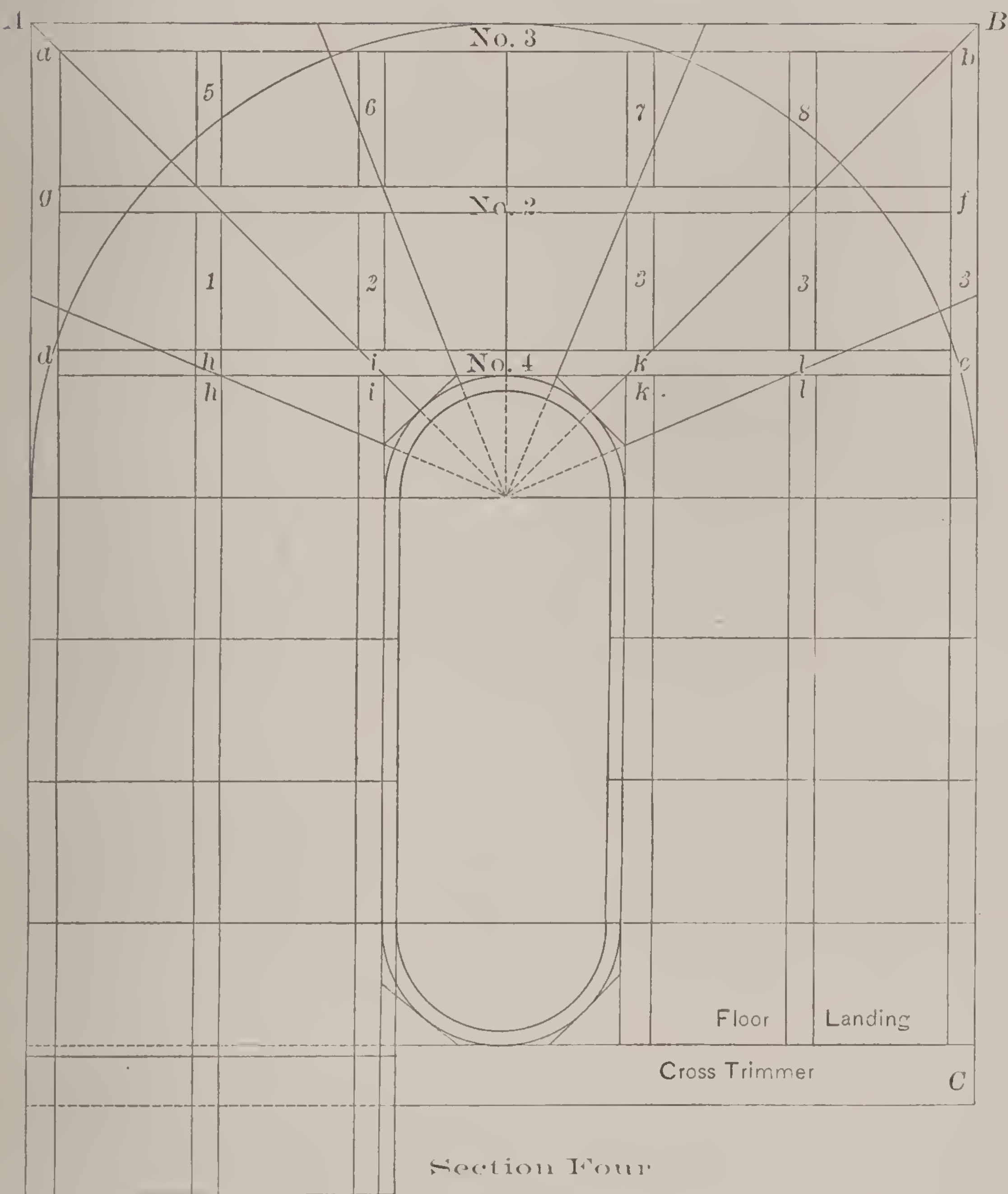
Fig. 3 is the elevation, showing the length of wreaths and straight rail, with skirting facia.

The newel is placed where it is, to show its relation to the rail only, the centre line being used to show the ramp of rail. The dotted lines show the relation of the rail to the elevation.




Section Three

Section Four exhibits a plan for a circular stairs in very common use, with a new method of framing the carriage for same. Wherever this method of framing the carriage




Section Four

has been adopted, it has proved satisfactory. It is strong, simple, and easy to construct, and in consequence, much more economical than any other method of framed carriages, and where a construction of the kind is required, I would recommend this method of building it. In showing this method of framing the carriage I have digressed somewhat from my first intentions, but, under the circumstances, I think the digression is permissible.

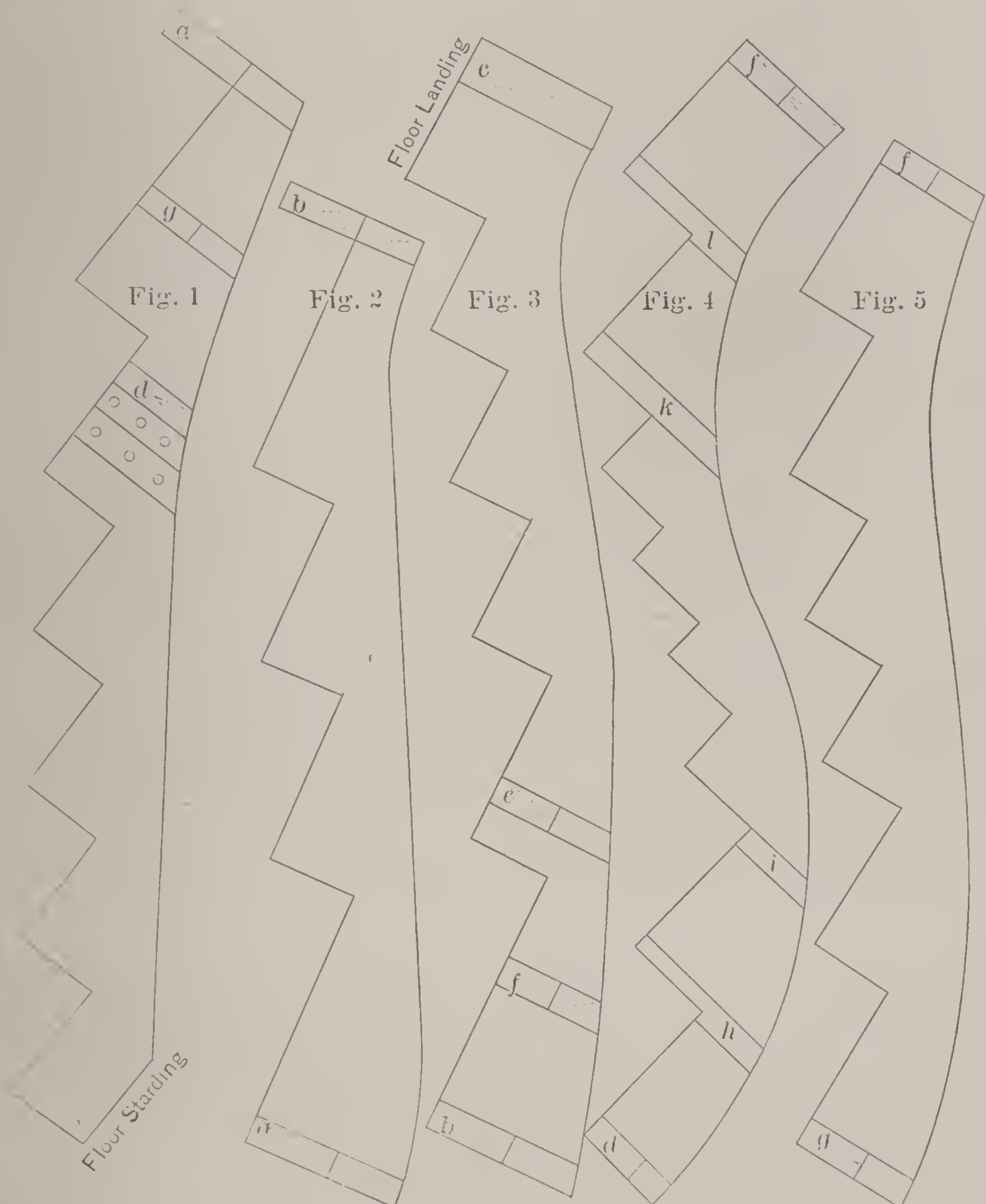
Section Five shows how the horse pieces for the stairs are laid out and cut. The figuring for these pieces should be readily understood, and the whole easily made and put in position in a substantial manner by any intelligent carpenter. In order, however, to aid in a thorough understanding of this method of framing a carriage of this kind of stair, I give the following explanation: Fig. 1 is the first piece to be worked and put in place; it runs up to the first angle at A, as shown in Section Four. Fig. 2 commences at A and extends to the next angle, at B. Fig. 3 commences at B and extends to the floor landing, at C. No. 4 is the first cross-piece in rear of the cylinder. All the other figures show the filling in pieces which are required to make the carriage strong and firm. These fillers should be fitted in between the main horse-pieces, snug and tight, and should be well spiked together or otherwise secured, as the lower and upper parts of the stairs mainly depend upon them for support. All the bevels for cutting the riser and tread lines can be obtained on the plan shown at Section 4. Allowance must be made for the thickness of the finishing risers and treads.

A good description of preparing the rough frames for carrying a stair is given in a small work entitled "Stair-building Made Easy."

Section 6 is a continuation of Sections 4 and 5, Fig. 1, showing the plan at Section 4, with the tangents drawn as at a, b and c; a, being the centre line, has all to do with the sector.

Fig. 2 is the stretch-out of winders in the wreath, with two lower flyers, and one above the cylinder. The rail shows the easements, which must be obtained in the usual way, with falling moulds. It will be seen that the falling moulds are straight with the exception of a slight curve at the end. After the concave and convex slabs are removed from the wreath-piece, thus giving the outer and inner twists, the application of the falling mould, as laid down, plenty wood will be found for its use in giving shape to the rail. Of course it is understood that kerfing is the mode for the top and bottom curves of the string.

Fig. 3 is the quadrant wreath-piece for Fig. 1, the end section showing the direction given to spring and plumb




Section Five

bevels. The same mould will answer both quadrants by reversing the bevels. It will be noticed that no lines calculated to confuse have been introduced, while everything the author has thought necessary to make the work clear

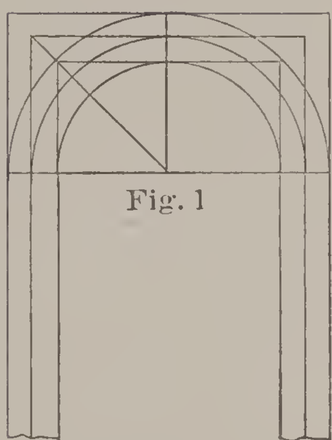


Fig. 1

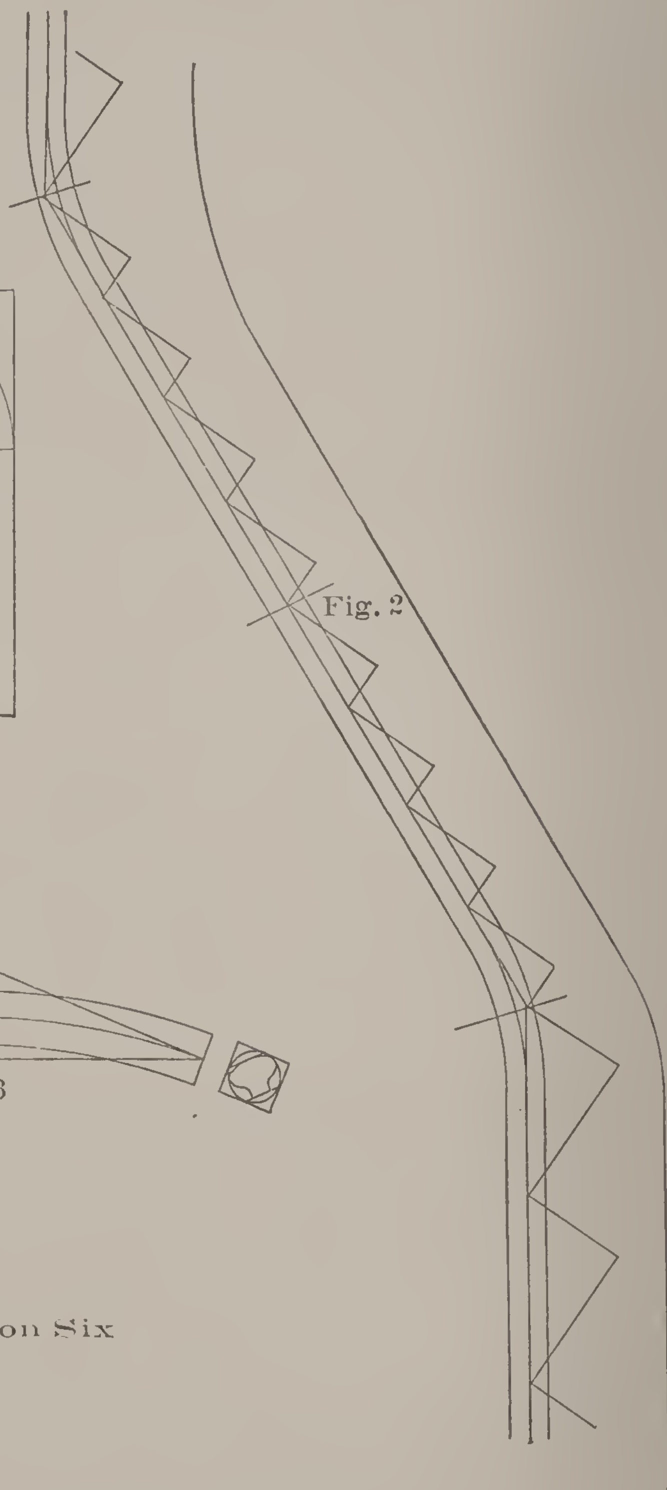


Fig. 2

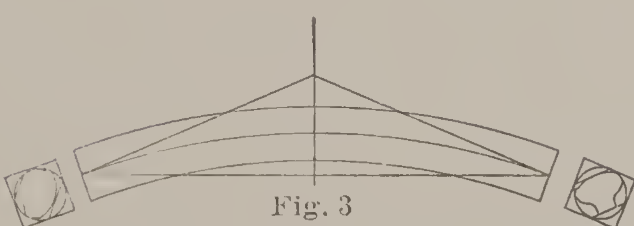
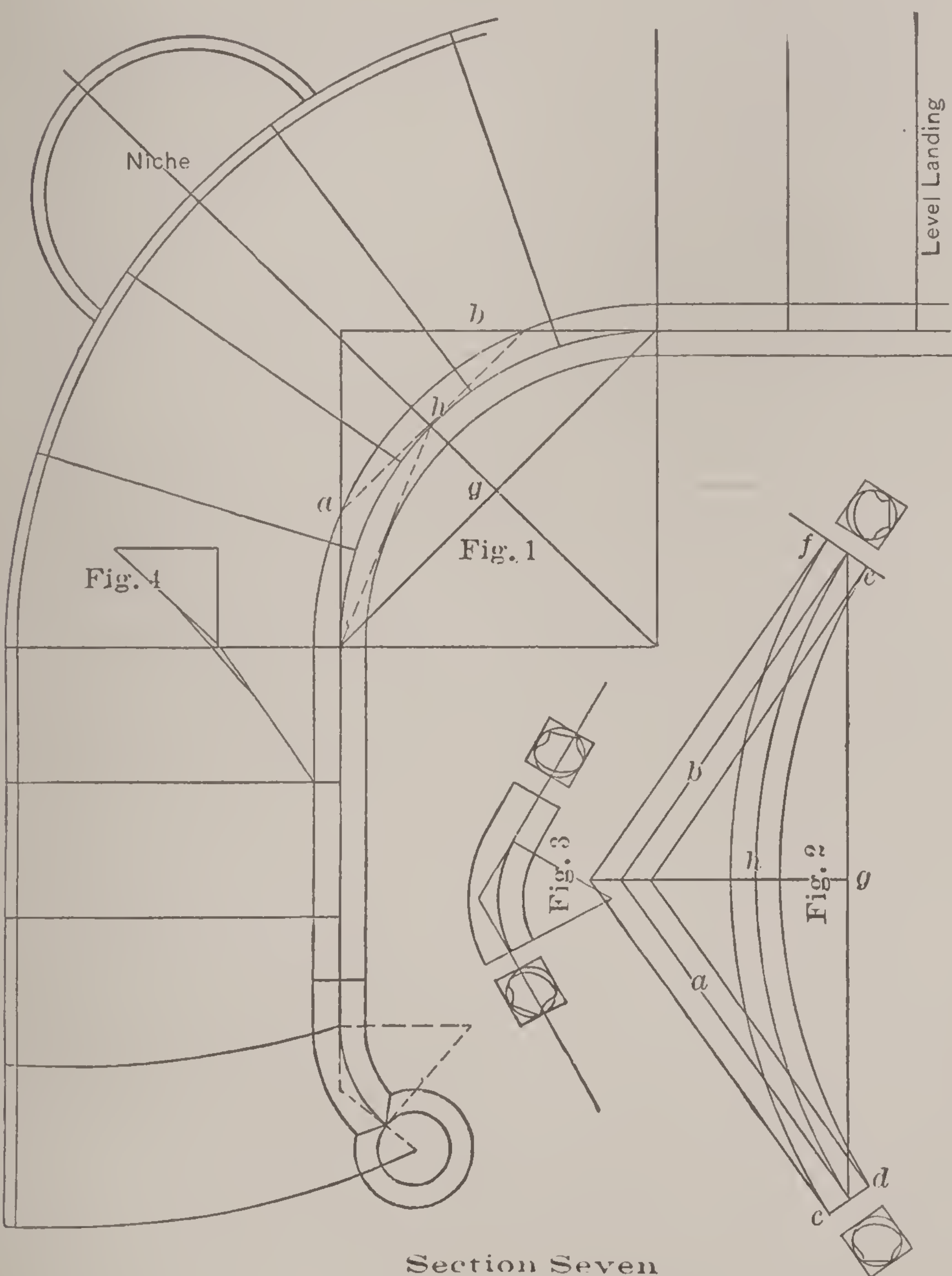


Fig. 3

Section Six

and plain to the comprehension of the ordinary workman has been embodied in the diagrams.

Section 7 shows a stair with winders in the quadrant, with a radius of two feet in the turning. Where the space is sufficient, a very imposing structure can be raised, giving character and effect to all the surroundings, if all are in keeping, which, of course, in a building where this kind of stair would be required, would be the case.




Section Seven

Suppose the newel to be twelve inches in diameter at the base, the rail six inches wide—well moulded—the balusters three inches in diameter at the base, treads four or five feet long, the open end handsomely finished with heavy nosings and mouldings, and the string finished with suitable brackets; and a large niche built in the angle, as shown, furnished with a suitable piece of statuary, the effect would be very fine and the cost not excessive.

Fig. 1 shows the plan of the cylinder with the quarter wreath all in one piece, which is obtained by working from the tangents, *a* and *b*. If it is found desirable to have the wreath in two pieces—which is sometimes the case—then the dotted lines show the angle of the tangents to be used. The height of two and a half, instead of five risers, will be the height for each piece.

Having laid down the plan as shown, proceed to obtain the whole length of wreath. Take the bevel and obtain the tangents from the sector as applied at *a, b,* Fig. 1, on the rake, and draw the lines, *a, b,* Fig. 2; get the length, and lay off width of rail to describe circle of wreath: stick pins at the points, *c, d, e, f,* and with a long blade bevel, each blade pressing against the pins, with a pencil in the angle, strike the circle, *g, h,* Fig. 2, to equal *g, h,* Fig 1.

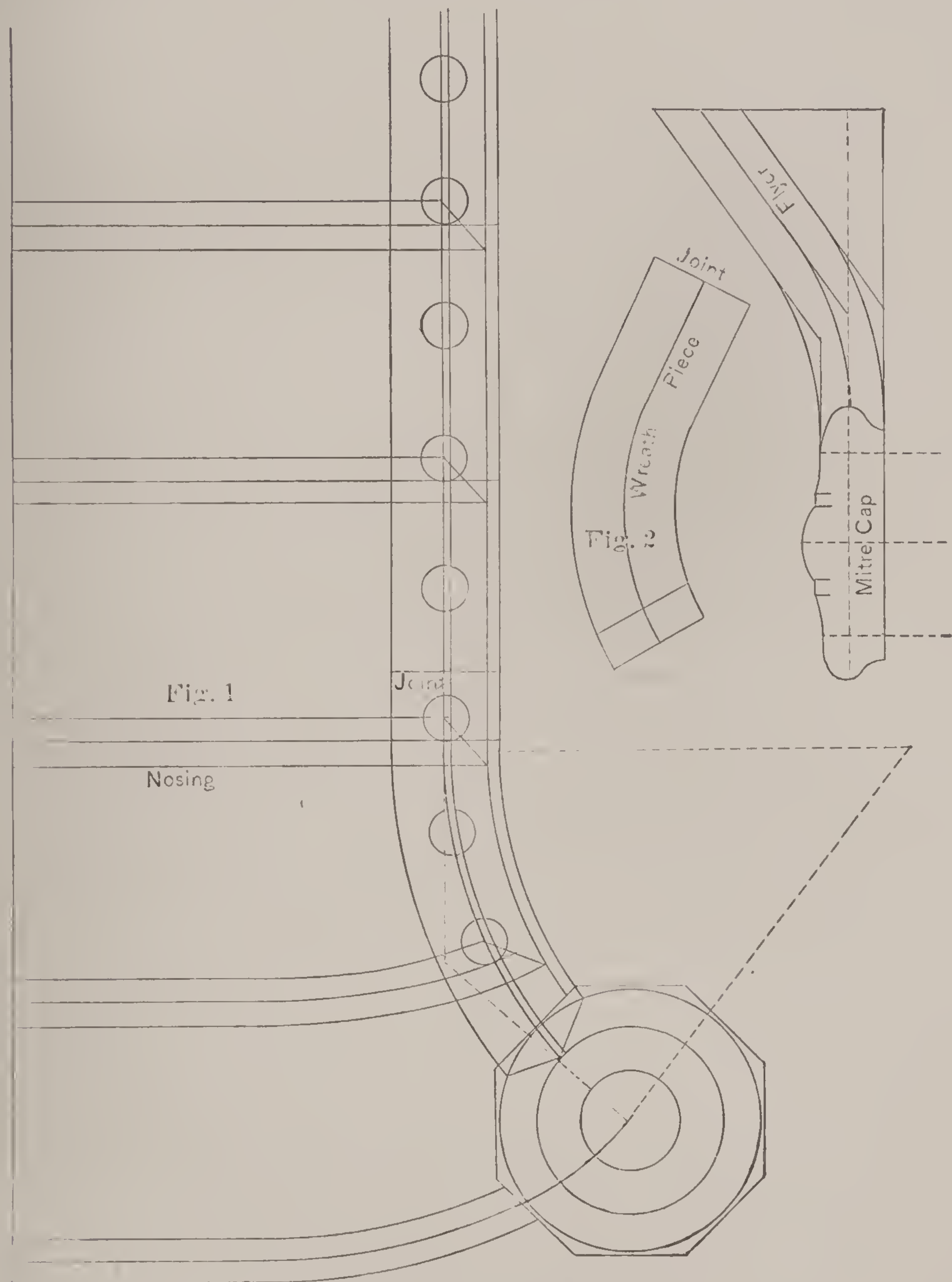
Fig. 3 shows the lower wreath and ramp. This is procured as before described. Fig. 4 shows the ramp connecting flyers to winders.

Section 8 exhibits the plan of the commencement of a better class stairway, intended for a house with a large and spacious hallway.

Fig. 1 is the plan of newel, cap, curved steps, balusters, etc. The curved risers are also shown, the bending of which any skilled workman can perform.

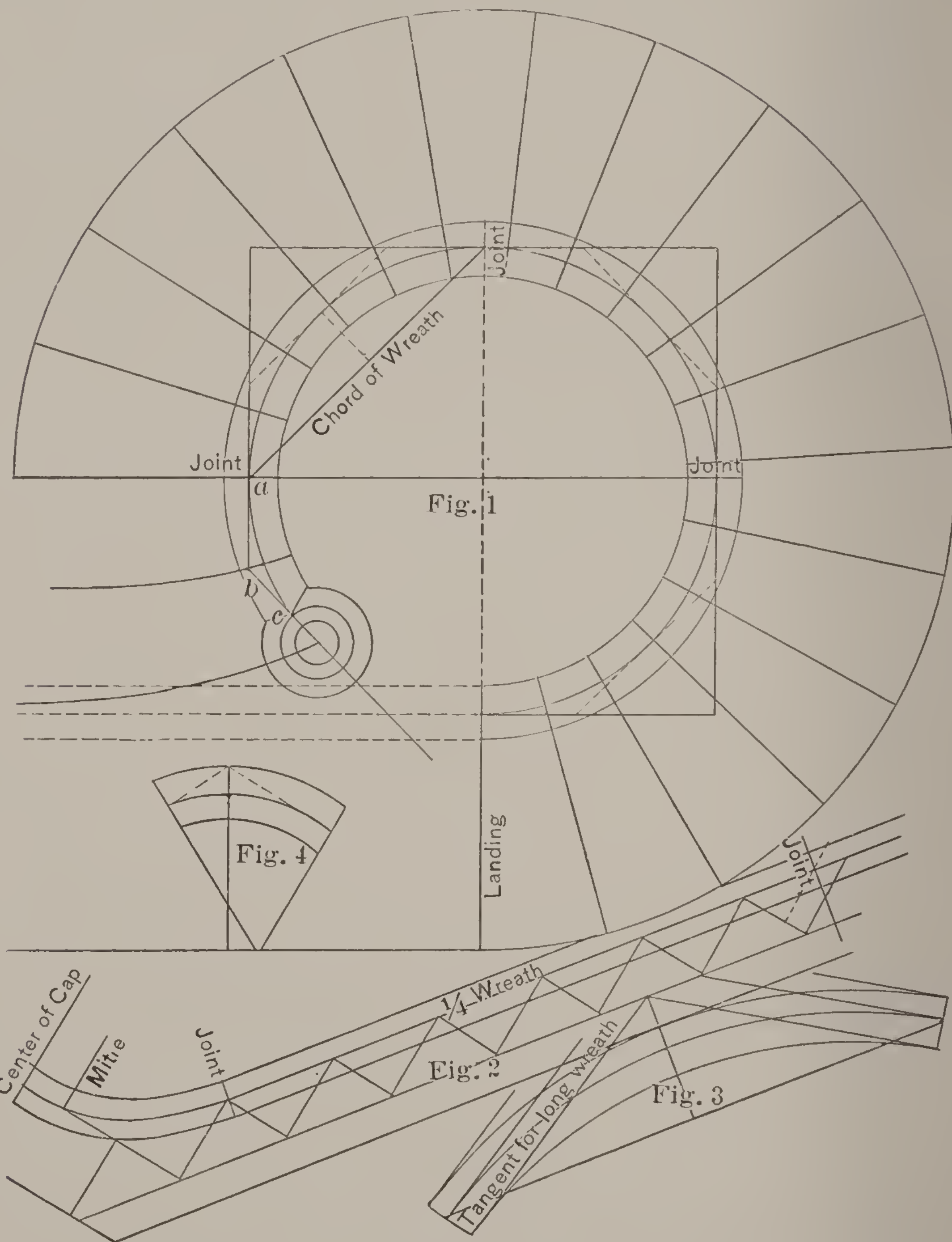
Fig. 2 is the starting wreath-piece, and is obtained in the way shown in previous sections, so needs no further explanation here. Fig 3 is a side view of Fig. 1, showing section of cap and elevation of rail. The falling moulds for wreath are obtained in the same manner as shown in preceding examples.

To obtain the spring and plumb bevels, resort must be had to the sector, following the instructions laid down in former examples having one leg of tangent bevel horizontal, and the other in the rake of a flyer; then apply the small bevel in the usual way on both leaves of the sector.




Section Eight

As it will be seen that by one leg being placed horizontal and the other on the rake of the flyer, the spring and plumb bevels are not of the same angle.



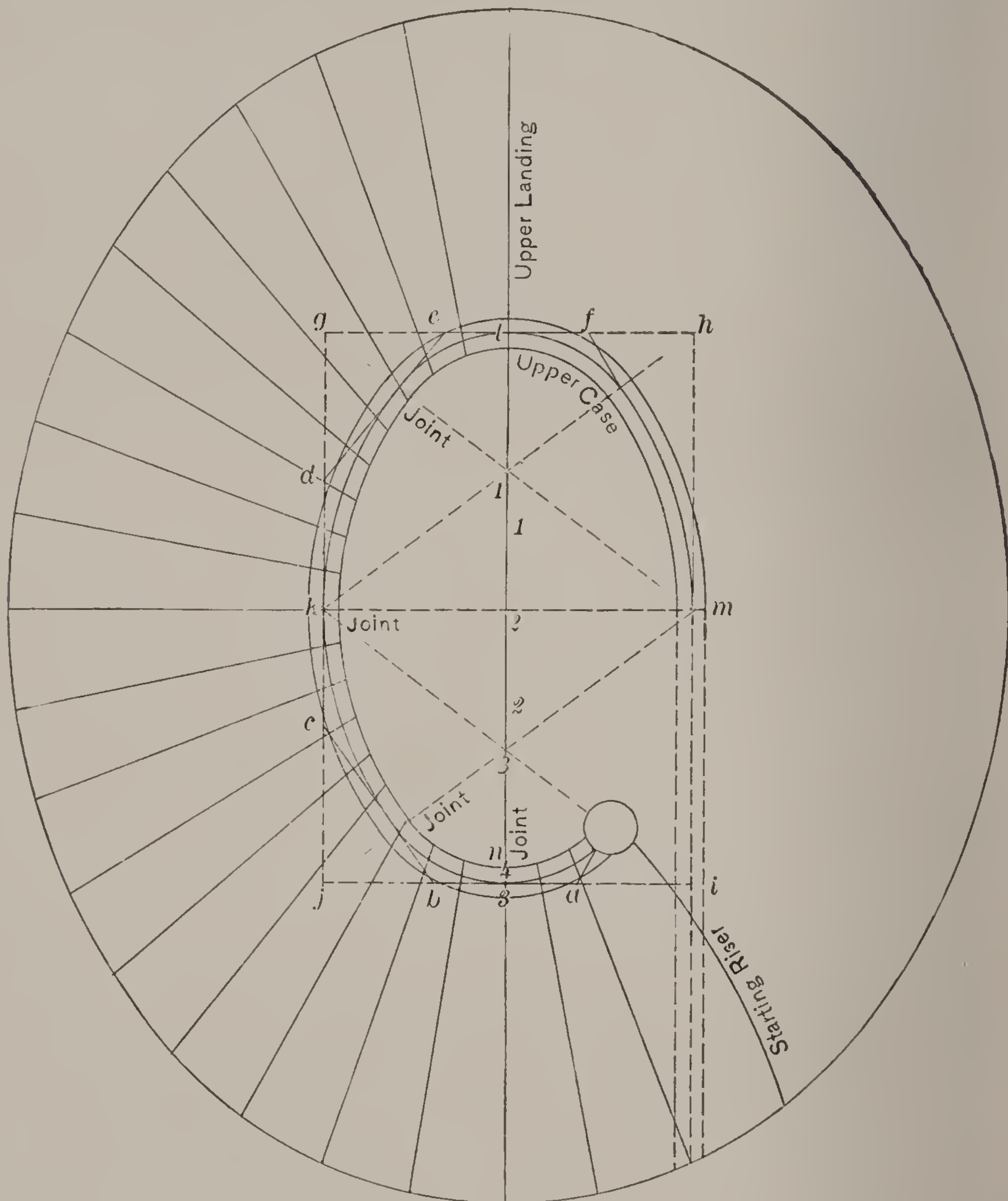

Section Nine

Section 9 shows a full circular stair, and the well-hole inclosed with tangents, either for quadrant or octagon angles, by which wreaths in either four or eight can be obtained. Where all the divisions are made equal, the same moulds, both face and falling, will answer for any section of rail. The moulds are applied, and all the twists and ramps obtained, as laid down in preceding examples. The framing is as easily put up as the framing shown in Section 4, which is the most economical, with the exception, perhaps, of those stairs which are cased in; then the frame work may be nailed together to suit the conditions; if left open, however, the method shown at Section 4 is as good as any, and as substantial. In the sketch shown, Fig. 1, is the ground plan, and where possible it should be laid out to full size on the floor where the stair is required to be built.

Fig. 2 shows the stretch-out of the wreath-piece for one-fourth of the circle, and is best when it is desirable to avoid many joints, though it is not always wise to have the wreaths so long, as there is apt to be too much cross-grained wood in the rail if they are made to encompass a quarter of a circle. This wreath is, of course, obtained in the same manner as other quadrant wreaths, with their tangents, chord lines and segments.

Fig. 4 is the lower wreath face mould, with the tangents as obtained from *a, b, c,* Fig. 1, and drawn as shown in the diagram. The lower end of Fig. 2 gives an idea of the falling easement, and in the shape of the centre falling mould the convex and concave falling moulds being obtained as in former examples.

At Section 10 an elliptical stair is shown, though this kind of stair is very seldom used in these latter days. In this case the well-hole is two-thirds the width of its length and all the lines are drawn within itself, and no line but the true segment of a circle used. It will be observed that the length is divided into four equal parts, and again into three, two of which are given to the width; then the points *k, l, m, n,* are used from which to describe the segments for the different sections of the wreath. The joints are made as laid down, square with tangents and face of plank. Be sure the plank has a true face to work from to insure a good job. Notice that *a, b, c, d,* are the angles




Section Ten

of the tangents, from which, by the aid of the sector, the bevels are obtained on the rake for describing wreath-pieces. The tangents with their angles *b* and *c* being respectively of the same length as *d, e,* the same mould will answer for both by reversing. The full size required for a stair of this pattern for a building of moderate size would be seven by thirteen feet, and could be very neatly placed in a recess made for the purpose. The reference letters, *g, h, i, j,* show the angles of the area of the well-hole. The dotted lines show the continuation of level rail on floor above.

This example has twenty-two risers, which, at seven inches each, would make a total rise of twelve feet ten inches from top of lower floor to top of upper floor, and a very ample pitch for the ceiling of the hall.

All the work necessary to complete this example and all the preceding ones, the author flatters himself, has been given to make this little work on Handrailing an acceptable offering to those for whom it is intended.

# APPENDIX.

## SOMETHING ON DESIGNING, PLANNING AND CONSTRUCTING THE CARCASES AND DETAILS OF STAIRWAYS.

In the designing and construction of stairways there is a number of important matters to be considered. The width, length and position of the well-hole and its surrounding timbers should be determined, then the run and the rise must be considered, in order to avoid having the lower steps running across, or approaching too closely, doorways or passages; and the front trimmer should be placed far enough from the top tread to insure, at least, seven feet of head room between the tread directly under the trimmer and the plastered ceiling. If there are landings in the stairway, and turns at any angle, full provision must be made in the well-hole to suit such landings and turns, and the trimmers around the well-holes should be made strong and should be well secured at the angles. If a carriage is employed to carry the stairs, it should be well framed into the wall where such is possible and should be well secured at each and every angle with nails, screws, bolts or straps. If only ordinary strings are employed, and the stairway is not boxed or closed in, the strings should be heavy and strong or be reinforced with a number of rough strings or bearers sufficient to make the whole stairs solid and firm under foot.

In planning a stairway care should be taken that it is so arranged that every room in the house is accessible from it, and, when possible in a building, there should be two flights, and they should not, as is the custom, be built so close together that the destruction of one by fire will render the other flight useless. We should follow the example set us by that most cunning of animals, the fox, and provide a place to get out, as well as a place to get into the house, and this second stair should be entirely separate from the one by which the building is mainly entered. There is no questioning the right of way out of a burning building; every one tries to save himself; "self-preservation is the first law of nature," and the fewer impediments, the quicker out of danger.

The leading idea in every stairway should be easy ascent and the straight line broken by a proper number of steps or landings in the most direct movement of the body. Winding stairs of any kind, as a rule, are an abomination, and if the statistics of the loss of life and injury caused by them could be arrived at, it would be seen that many more accidents happened thereby, after buildings were tenanted, than ever occurred during the dangers and hazard of construction. Aesthetically a winding, or elliptical, staircase, describing its curves of grace, is pleasing to the eye. But is it beauty when we consider the difficulties and cost of the construction? The steps of winding stairs are not parallel—one end too wide, the other too narrow, leaving but a space in the centre or rim of the steps as the only suitable place for ascending or descending. With such uncertain footing, they are manifestly objectionable, and were it not for a railing to guide, would not with perfect confidence be tolerated. The only real advantage derived from the use of winders in stairs is economy of space. The landing stair, on the contrary, with its short flights and easy steps in mounting, square and spacious, and in perfect repose, conveys in its "make-up" precisely what it is—a simple, substantial, appropriate piece of work, commending itself to practical common-sense. Wherever space and other conditions will admit, a platform stair should be employed; but, of course, there will always arise instances where circular, or dog-legged, stairs must be built, and to provide rails for the former the system presented in the text of the main body of the work is well adapted.

In determining the height of riser and width of tread, the designer will be obliged to consider the length of run and height of total rise at his disposal. The diagram or inclinator shown at Fig. 1 will aid very much in finding the proper pitch of any stairway if its principles are followed. A shows the run of the stair, B the rise, and C the inclination. As the angle of ascent will vary with

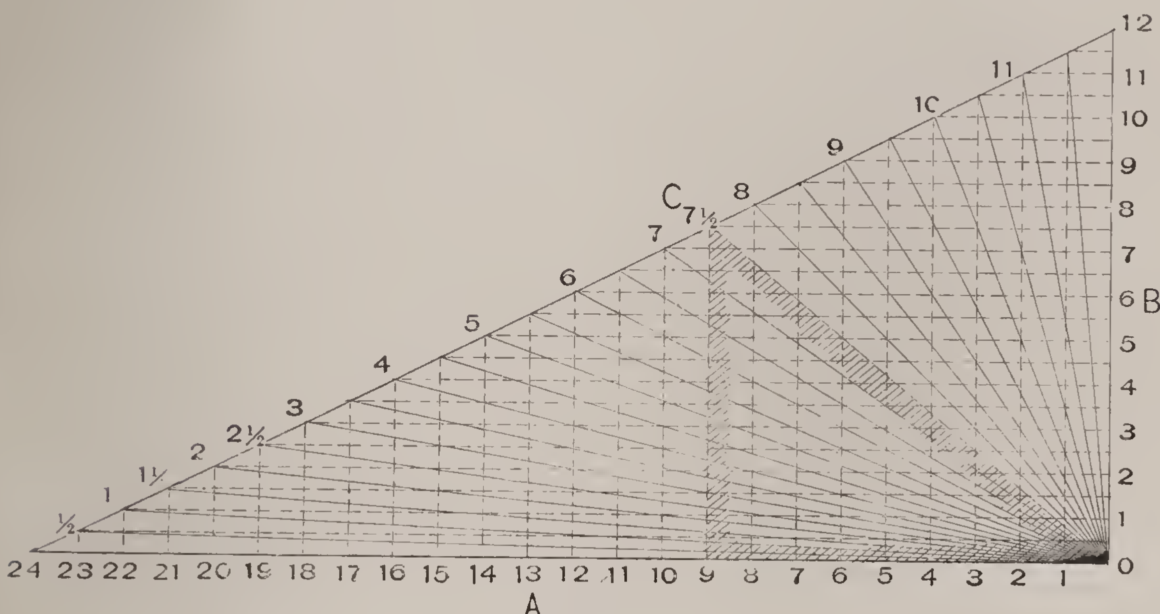



Fig. 1

circumstances, the following treads will determine about the right inclination for different classes of buildings:

For public edifices, make tread about 14 inches.

For first-class dwellings, make tread 12½ inches.

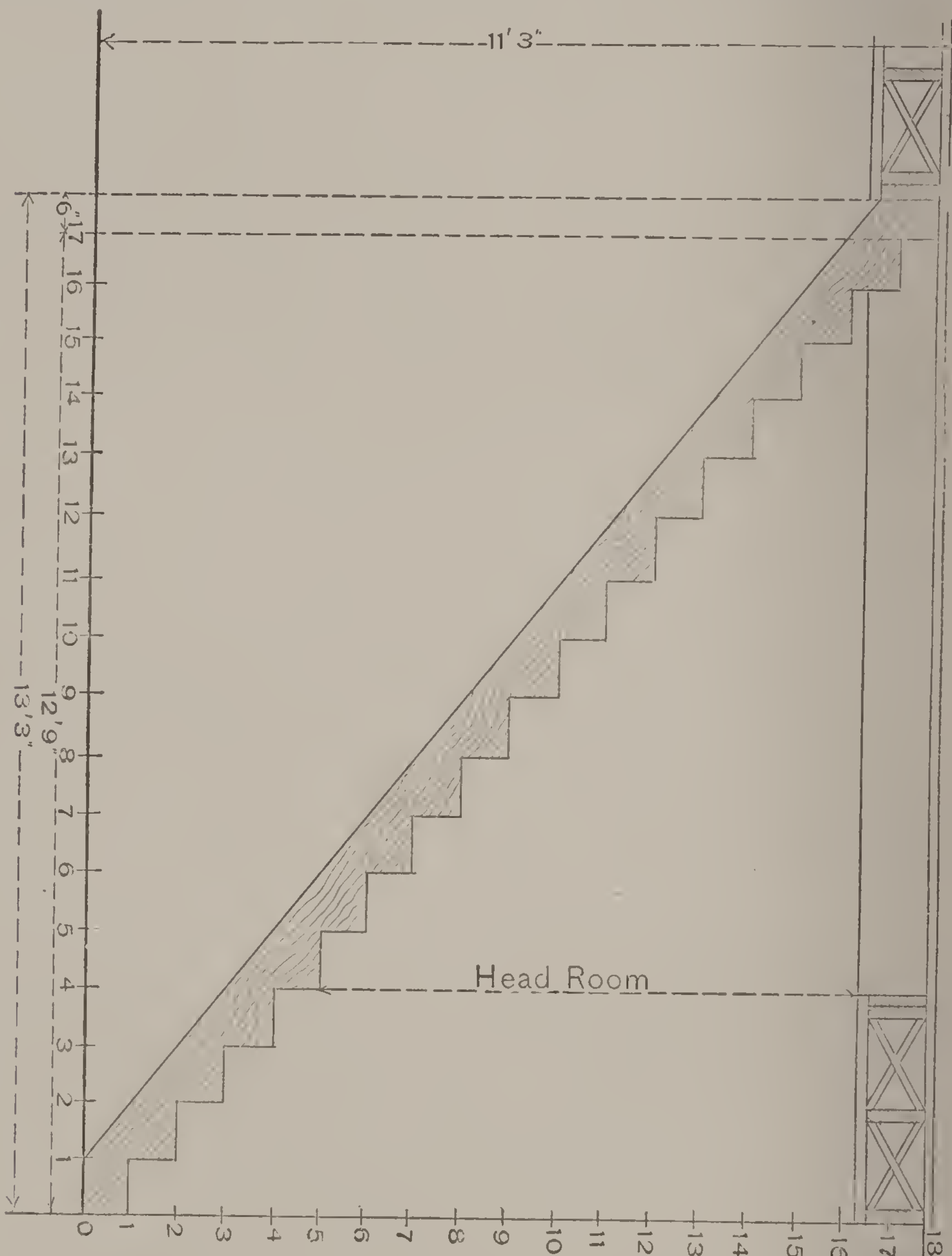
For second-class dwellings make tread 11 inches.

For third-class dwellings, make tread 9 inches.

Treads should never be less than nine inches wide in any stairway built for general use. Back and attic stairs may have treads less than nine inches wide, but the greater width should be employed where possible.

At Fig. 2, an example is shown of the manner in which the inclination may be used in determining the proper proportion for treads and risers. Take the total height measured from top of floor to top of next floor above, which is here shown to be 11 feet 3 inches. Having decided that 7½ inches will be the height of riser, we look on the inclinator for 7½, and find that it gives a

9-inch tread. Then take $7\frac{1}{2}$ inches and divide 11 feet 3 inches by it, and we find that it gives us 18 risers and 17 treads. (There is always one more riser than tread.) Multiply the number of treads (17) by 9 inches, the width




Plan
Fig. 2

of tread, which gives us 12 feet 9 inches, to which add half the diameter of cylinder, and we get the total length of the "run" of the stairs, or the horizontal line on the floor covered by the stairs as shown in the sketch. In

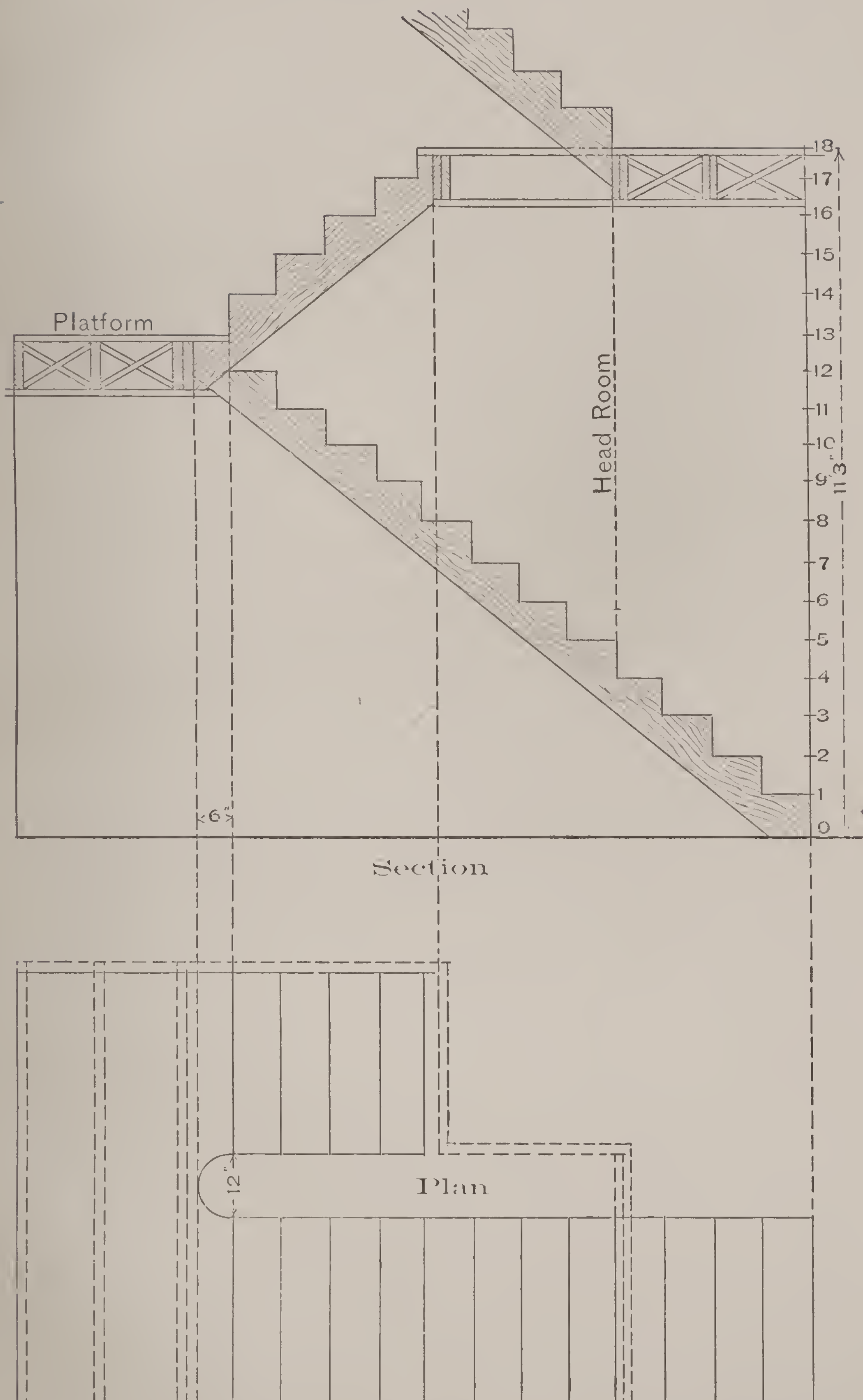

Platform
Head Room
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
11' 3"
6"
Section
12"
Plan

Fig. 3

this case a cylinder is employed having a diameter of 12 inches, half of which is 6 inches, which gives a total length of run of 13 feet 3 inches, from where the stairs start to line of landing. The head-room determines the length of well-hole, and is found by measuring from the tread to the plaster a distance not less than 7 feet, as otherwise it will obstruct an easy walking down stairs. The well-hole is shown to have double joists for trimmers,

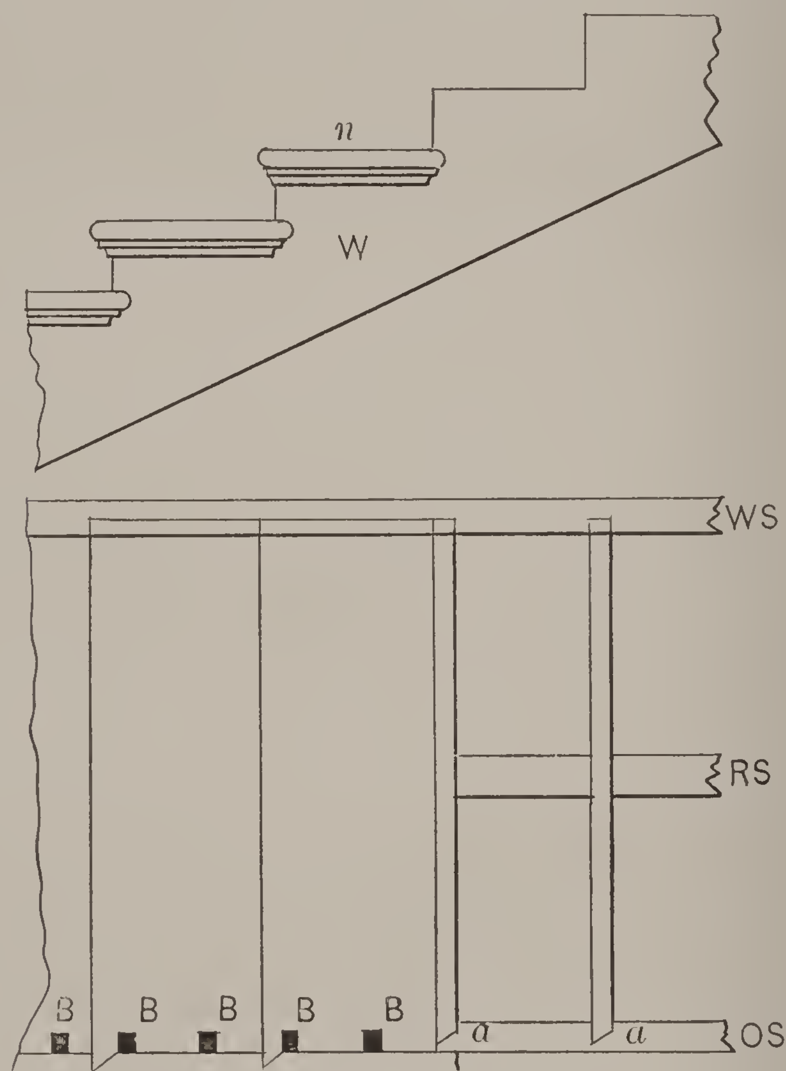



Fig. 4

which line three sides of the opening, the fourth side being part of a wall. The open or cut string is shown, which should be made of good, clean, straight-grained plank, reinforced on the inside with a heavy scantling on a line with the junction of the riser and tread. The "pitch-board" is shown at the shaded portion of the inclinator, Fig. 1, which shows how any pitch-board for stairs having rise of half an inch to 12 inches, and a tread from 1 inch to 24 inches wide. Fig. 3 illustrates a platform stair having the same rise and run of the previous example. A plan and sectional view is given, showing the platform and the method of finding the head-room, well-hole, and starting point for second-story flight. The dotted lines show the trimmers forming the well-hole and the manner of framing them. The cylinder is shown at the platform, and here it is well to note that a portion of the cylinder shows on the face of the string starting from the platform or landing.

Another method of obtaining a fair proportion for treads and risers, and which seems to be quite popular, is shown as follows: Set down two sets of numbers, each in arithmetical progression, the first set showing the width of treads, ascending by inches, the other showing the height of the risers, descending by half-inches. It will readily be seen that each of these treads and risers are such as may suitably pair together:

| Treads in inches. | Risers in inches. |
|---|---|
| 5 | 9 |
| 6 | 8½ |
| 7 | 8 |
| 8 | 7½ |
| 9 | 7 |
| 10 | 6½ |
| 11 | 6 |
| 12 | 5½ |
| 13 | 5 |
| 14 | 4½ |
| 15 | 4 |
| 16 | 3½ |
| 17 | 3 |
| 18 | 2½ |

It is seldom, however, that the proportion of the tread and riser is exactly a matter of choice. The room allotted to the stairs, as before mentioned, usually determines this proportion; but the foregoing rules will be found a useful standard, to which it is desirable to approximate.

In the better class of buildings, the architect usually figures out the number of treads, and when such is the case, the workman has no alternative but to divide his story rod to suit the number of treads laid down in the plan.

At Fig. 4 a sketch of a portion of a string is shown, having a *cut and mitred string,* or what is generally known as an *open string* stair. In the lower portion, which shows the plan, W S represents the wall string, which must be well secured to the wall or partition; R S shows the rough string, which is placed there to give strength to the whole structure. It is so made that every tread gets a good bearing upon it. It is generally made of heavier stuff than the outer strings. O S shows the outer or cut string, W, as shown in the upper part ofthe illustration. At *a a* the outer ends of the risers are shown, and it will be noticed they are mitred against the vertical or riser line of the string, thus preventing the end-wood of the riser from being seen. The other end of the riser is shown in the housing of the wall string. The outer end of the tread is also mitred at the nosing, and a piece of stuff made or worked like the nosing, which is mitred against, or returned, at the end of the tread. The end of this returned piece is again *returned on itself* back to the string, as shown at *n* on the string W. The moulding under the nosing, which is usually a $\frac{5}{8}$ cove, is also returned round the string and into itself. The finished treads shown at W are shown in plan at B B B, etc., where the projection of the nosings and the mitre joints are seen. The square black spots shown are the mortises or dove-tails for receiving the lower tenons of the balusters. It is always best to saw the ends of the treads ready for the balusters before they are attached to the string; then when the time arrives to put up the rail the back end of the mortise may be cut out, when the tread will be ready to receive the baluster. The mortise is dovetailed, the spread being on the lower side of the tread, and, of course, the tenon in the baluster must be made to suit. The tread should be finished at the bench and the return nosing properly fitted to it and lightly tacked on so that it may be readily taken off to insert

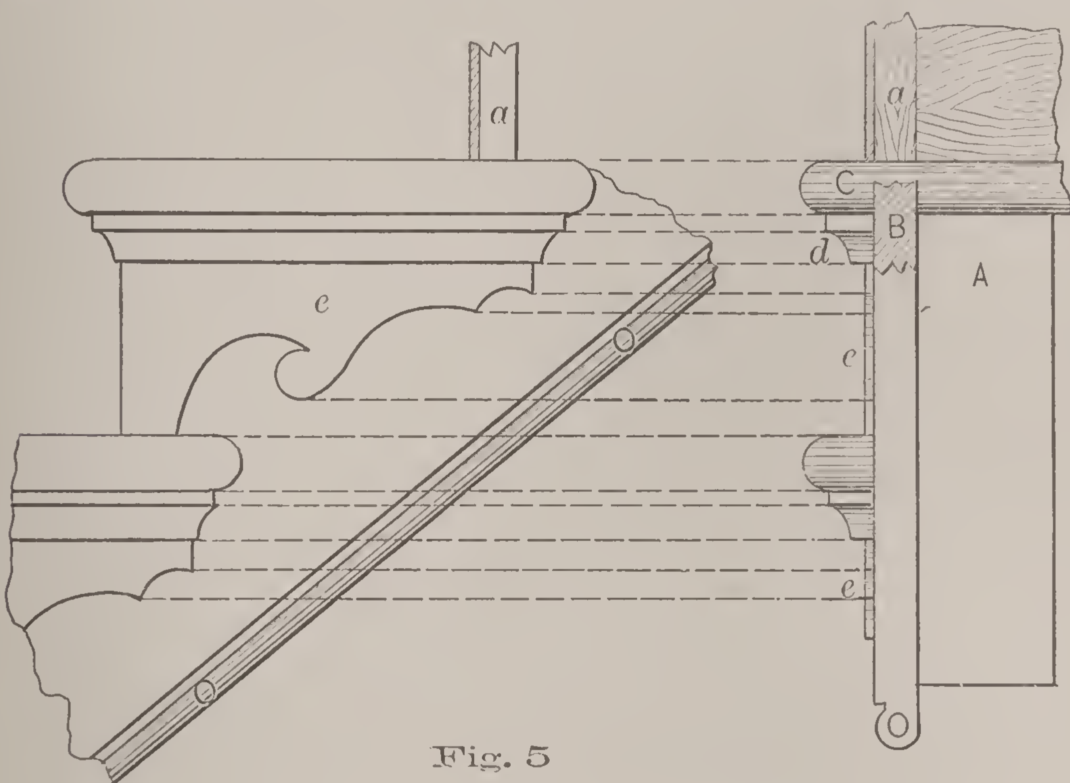



Fig. 5

the balusters, when the rail is being put in position. If the cut string is to be bracketed as shown at Fig. 5, then the tread and riser must be left long enough to cover the bracket, which is usually about three eighths of an inch thick. A section of the string, bracket and nosing is

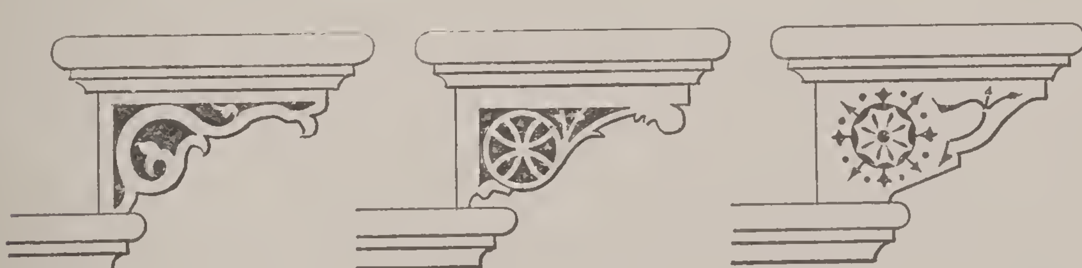


Fig. 6

shown in Fig. 5, where A represents a rough cut string, *t* a finished casing string, *c* the nosing, *d* the cove moulding, and *e e* the bracket; *o o* shows the bead, both in section and on the rake.

When brackets are employed, the angle showing at the cut-string end of the riser is mitred to the riser so that no end-wood is seen at the junction of bracket and riser.

Fig. 6 shows three other examples of stair brackets from which inspiration may be drawn for other designs.

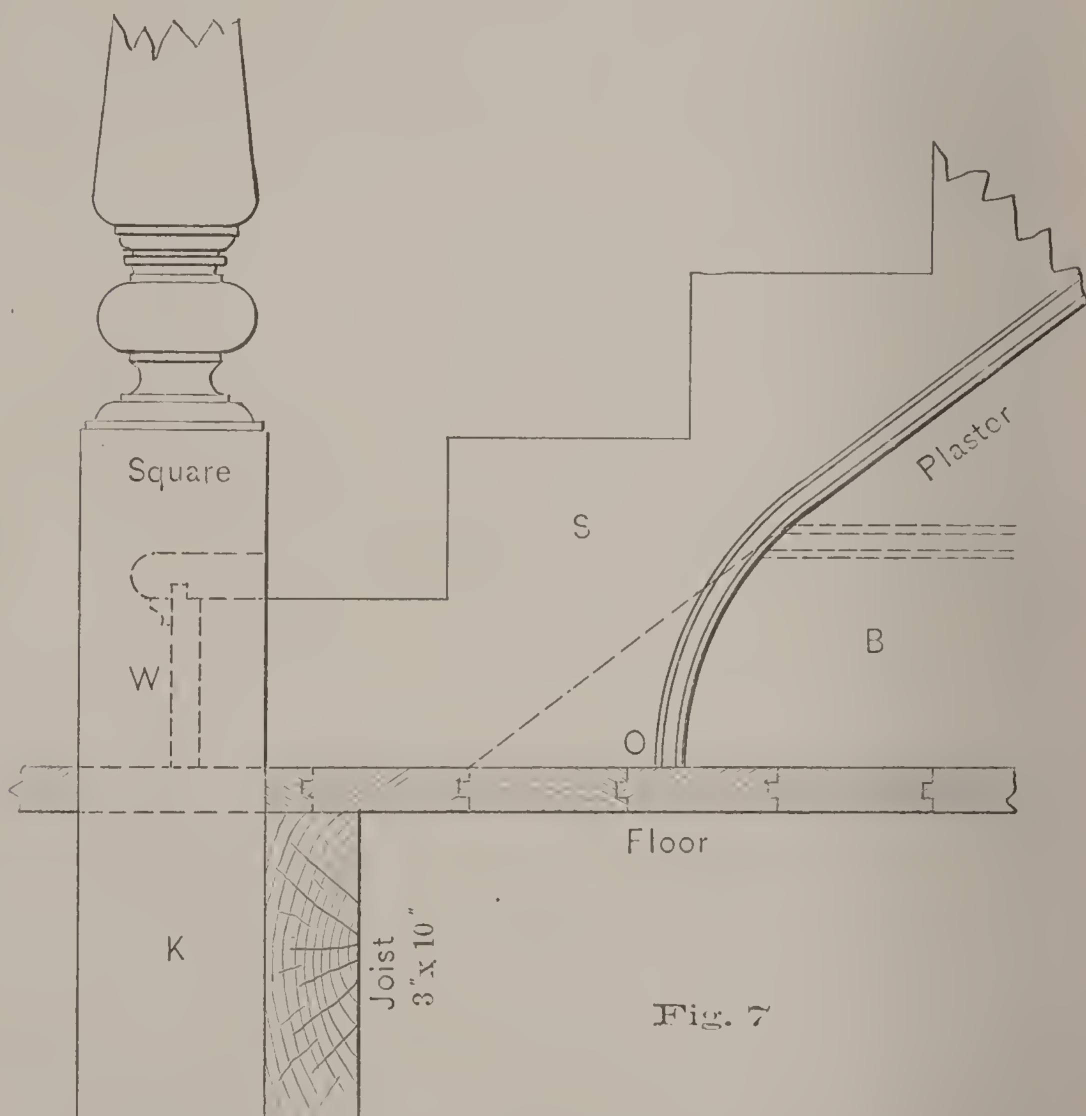



Fig. 7

Fig. 7 shows how a cut-string is sometimes attached to the newel at its lower end. The point of the string should be tenoned into the newel, K, three or four inches, as shown by the dotted lines, and the square of the newel should run down through the floor and be well secured to a joist when possible.

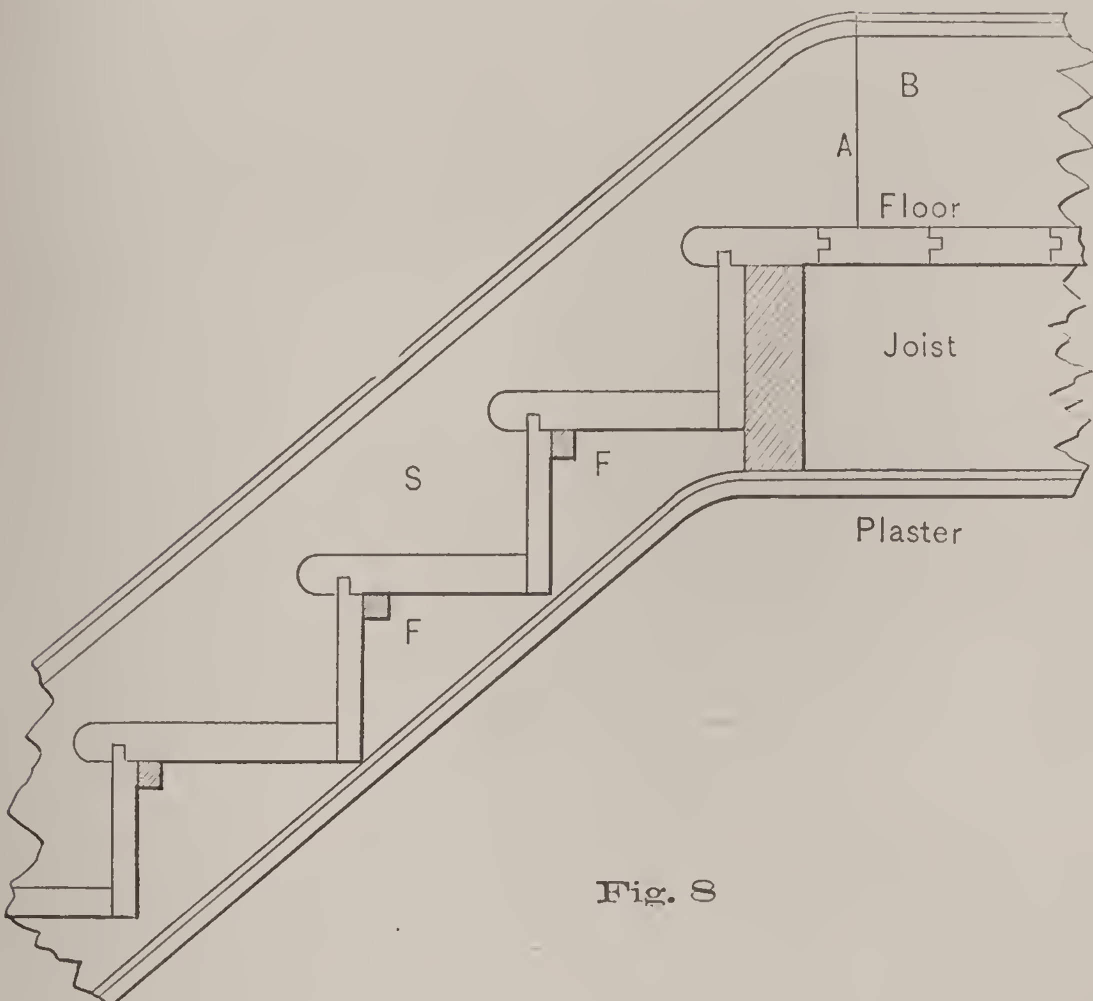



Fig. 8

Fig. 8 shows the manner in which the wall string, S, is finished at the top of the stairs. It will be noticed that the moulding is worked round the ease-off at A to suit the width of the base-board at B. The string is cut over the floor horizontally and vertically or plumb against the joists. The plaster line under the stairs and in the ceiling is also shown.

Fig. 9 exhibits a method for connecting a small cylinder to the strings, in order to make a good and strong joint. It will be seen that the cylinder is notched out on the back, and the two blocks shown at the back of the offsets are wedges driven in to secure the cylinder in place, and to drive it up tight to the strings. This is better shown at Fig. 10, where the dotted lines show the

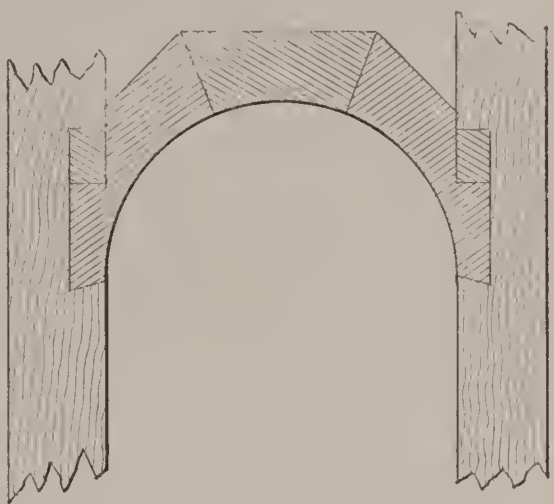


Fig. 9

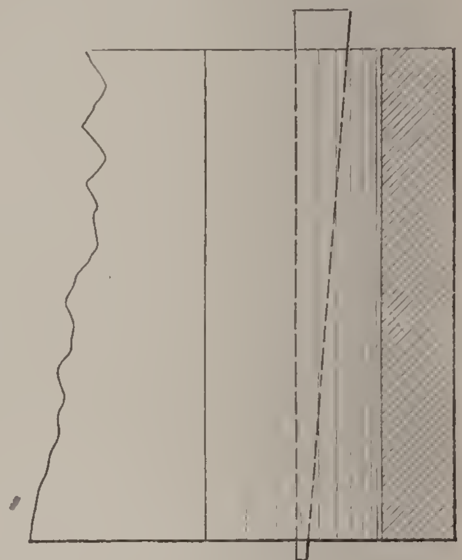


Fig. 10

position of the wedge. This method of fixing the cylinder is so clearly shown in the illustrations that further description is unnecessary.

# INDEX.